DEPARTMENT OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY

Chair of Computer Technology in Construction

DIPLOMA WORK

Modern methods of shallow foundation strengthening of high school building

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The following issues were revealed in the thesis:

- The question of urgency of strengthening of the bases by banquets is considered;
- The basic methods and ways of strengthening of the bases (on an example of the columnar base) are considered;
- The constructive ways of the bases are resulted; The calculation of the reinforcement of the columnar foundation in the software package Plaxis 3D;
- Another part of diploma project, such as: architectural part, structural part, organization of construction, labour precaution etc.

Abstract

The problem of foundation strengthening in the reconstruction of houses is especially relevant in large cities. The main reason is commercial the attractiveness of buying houses in the central part of the city and superstructure of additional floors. As a result, increase load on the foundation

The main reasons for the need of foundation strengthening are an increase in the load when adding buildings or change of their functional purpose, disturbances in coupling of masonry materials, the destruction of the foundation material from the action of aggressive environments, deformations due to loss of strength or sedimentation of the bases. Depending on the design of the foundations, as well as the nature of deformations and the reasons, their daring, various ways of repair and strengthening are applied deformed foundations.

The issue of reconstruction is very relevant today. Exactly reconstruction of already operated industrial and residential buildings is one of the primary problems of modern builders.

Methods of shallow foundation strengthening

The following methods should be used to repair and strengthen foundations:

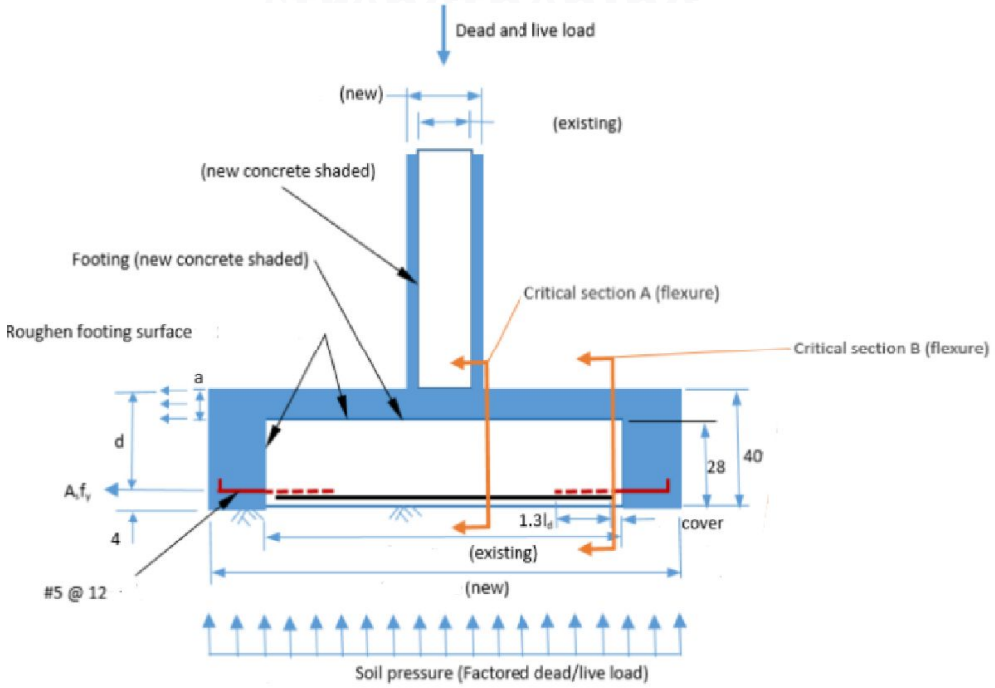
- injection into the body of the foundation of cement mortar, synthetic resins, etc .;
- arrangement of reinforced concrete clips (shirts) around the existing foundation;
- jacketing
- increasing the bearing area of the base of the foundation
- introduction of additional supports for unloading of the existing base;
- reinforcement of foundations with piles.

Reinforcement of the foundation body by injection of cement mortar or synthetic resins is done by drilling holes in the body of the foundation holes or holes, installing injectors and feeding through them under the pressure of the fixing solution, which fills cracks, voids, weakened areas.

When reinforcing the foundations with reinforced concrete clamps for communication with the existing foundation clamps are anchored with rods.

To ensure the adhesion of new concrete to the old, it is necessary to clean the surface of the old concrete by pressure washing with water, chemicals (for example, hydrochloric acid solution), by sandblasting dry or wet methods, followed by notching with perforators or jackhammers.

Methods of strengthening foundations by jacketing



If it is impossible to increase the bearing capacity of the foundation - increase the area of the foundations. The increase in area is performed in two ways: without compression of the base soil and with pre-compression. In the first case, the increase in area is carried out with the help of additional parts (banquets), which can be unilateral (with off-center load), or bilateral (with central).

Strengthening the foundations by Jacketing (expansion area of the foundation) is widely used. In practice, this method used repeatedly, but its main disadvantage is that it is required excavate the soil to the base of the foundation, which carries, in some cases, high costs on the economic and labor-intensive part.

Constructive methods of shallow foundation strengthening

The choice of the method of reinforcement and reconstruction of the shallow foundation foundations (both tape and columnar) depends on the reasons that necessitate such reinforcement, the structural features of the existing foundations and the soil conditions of the site.

The methods used in such cases are divided into the following groups:

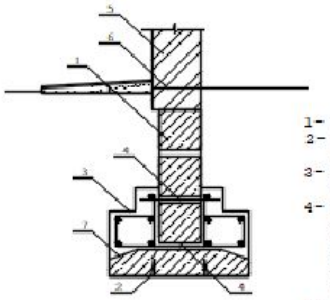
- In conditions of destruction of the foundation material, insufficient load-bearing capacity of the foundation and the need to partially increase the load, masonry reinforcement is used by injecting cement mortar into cavities, replacing a weak section of the foundation, installing concrete or reinforced concrete clamps without expanding or expanding the foundation
- With a large thickness of weak soils d foundation, corrosion or other destruction of the foundation, the need to increase the depth of laying or change the underground part of the building carry out the supply of structural elements (slabs, columns) under the existing foundations. Supply of columns and slabs is performed in a checkerboard pattern or by a solid wall.

The calculation and design of the reinforcement of shallow foundations must be carried out in accordance with the standards

When increasing the area of the sole of the foundations, it is necessary to take into account the increase of the depth of the active zone of the foundations of the foundations and the different deformation and strength characteristics of the soils under the sole of the existing foundations and under extensions.

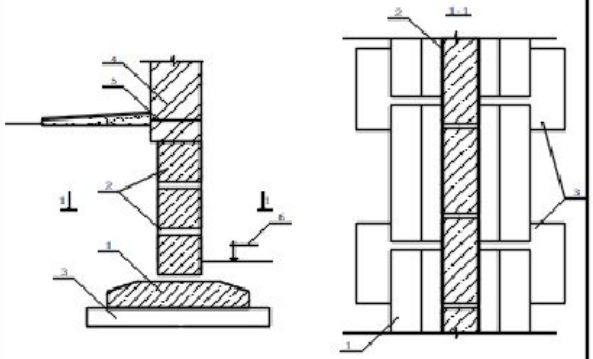
Type of shallow foundations strengthening

ARRANGEMENT OF LONGITUDINAL BEAMS (SPLICING) ON JUMPS



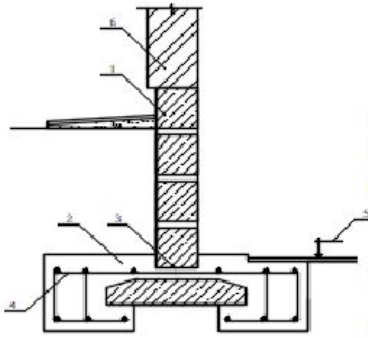
1- existing foundation;
2- cracks in foundation plate part;
3- reinforced concrete splice;
4- holes in joints between blocks for placing the principle reinforcement (should be filled with liquid cement mortar);
5- brick masonry;
6- hydraulic seal;
7- surface prepared for concreting

INCREASING OF BEARING AREA BY ADDITIONAL PADS



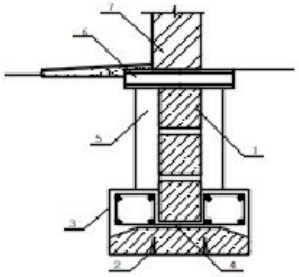
1- pad of existing foundation; 2- foundation blocks; 3- cast-in-place reinforced concrete additional pads; 4- brick masonry; 5- hydraulic seal; 6- basement floor mark

INCREASING OF BEARING AREA BY REINFORCED CONCRETE YOKE ARRANGEMENT



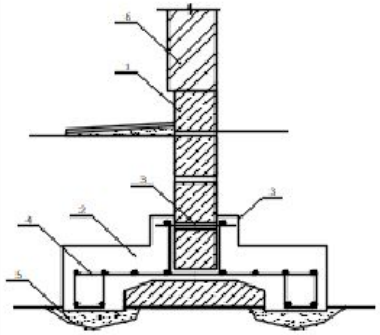
1- existing foundation;
2- reinforced concrete yoke;
3- holes in joints between blocks for placing principle reinforcement ;
4- basic principle reinforcement of strengthening;
5- basement floor mark;
6- wall brick masonry

ARRANGEMENT OF LONGITUDINAL BEAMS WITH POSTS ON JUMPS



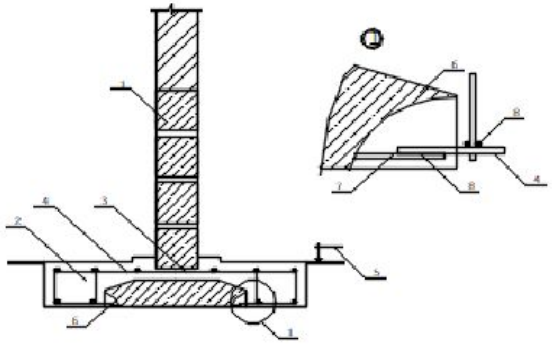
1- existing foundation;
2- cracks in foundation plate part;
3- longitudinal reinforced concrete beams;
4- holes in joints between blocks for placing principle reinforcement;
5- reinforced concrete posts;
6- metal beams;
7- brick wall

INCREASING OF BEARING AREA BY REINFORCED CONCRETE YOKE ARRANGEMENT



1- existing foundation; 2- reinforced concrete yoke; 3- holes in joints between blocks for placing principle reinforcement; 4- basic principle reinforcement of strengthening; 5- packed soil zones; 6- wall brick masonry

INCREASING OF BEARING AREA BY REINFORCED CONCRETE YOKE ARRANGEMENT



1- existing foundation; 2- reinforced concrete yoke; 3- holes in joints between blocks for placing principle reinforcement; 4- basic principle reinforcement of strengthening; 5- basement floor mark; 6- concrete cut off surface; 7- reinforcement outlets in pad; 8- welding

Calculation of foundation reinforcement in the Plaxis 3D

For mathematical modeling of shallow strip foundation laying with the arrangement of jackting in the basis the software product Plaxis is chosen3D, which is based on the use of the numerical finite element method.

The settlement complex Plaxis is a target package of geotechnical programs for finite-element analysis of the stress state of the system "building basis" in a flat and spatial setting. All models of materials that used, based on the relationship between the rate of change of effective deformations and the speed of deformation. Such a dependence can be presented as follows

$$\sigma = M \cdot \varepsilon ,$$

M- is the stiffness matrix of the material.

In equation the tensors of the rates of change of stresses and strains are presented in vector form and include six Cartesian components (for spatial problem)

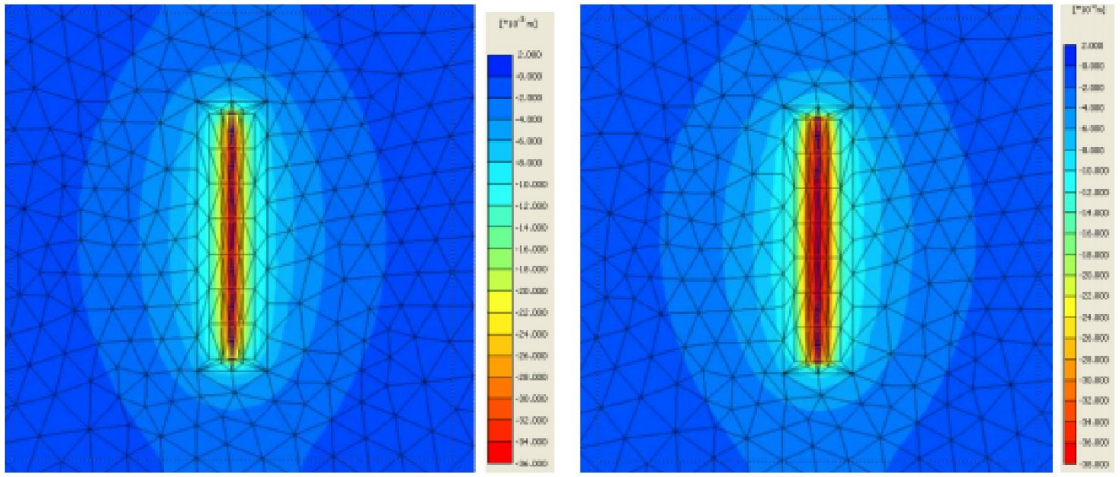
When developing certain models of materials, the main ones are used stresses, not Cartesian stress components. In the case of a flat or axisymmetric strain principal stresses are calculated on the basis Cartesian stresses according to the formulas:

$$\begin{cases} \sigma_1 = \frac{1}{2}(\sigma_{xx} + \sigma_{yy}) - \sqrt{\frac{1}{4}(\sigma_{xx} - \sigma_{yy})^2 + \sigma_{xy}^2}\ ; \\ \sigma_2 = \sigma_{zz}; \\ \sigma_3 = \frac{1}{2}(\sigma_{xx} + \sigma_{yy}) + \sqrt{\frac{1}{4}(\sigma_{xx} - \sigma_{yy})^2 + \sigma_{xy}^2}\ . \end{cases}$$

In Plaxis, the principal stresses are placed in an algebraic sequence $\sigma_3 < \sigma_2 < \sigma_1$, here σ_1 - the greatest compressive stress.

Calculation of foundation reinforcement in the Plaxis 3D software package

Plane strain and axial symmetry, indicating the geometric types handled in the original code) is a computer programe that performs finite element analyses (FEA) within the realm of geotechnical engineering, including deformation, stability and water flow. The input procedures enable the enhanced output facilities provide a detailed presentation of computational results. PLAXIS enables new users to work with the package after only a few hours of training.



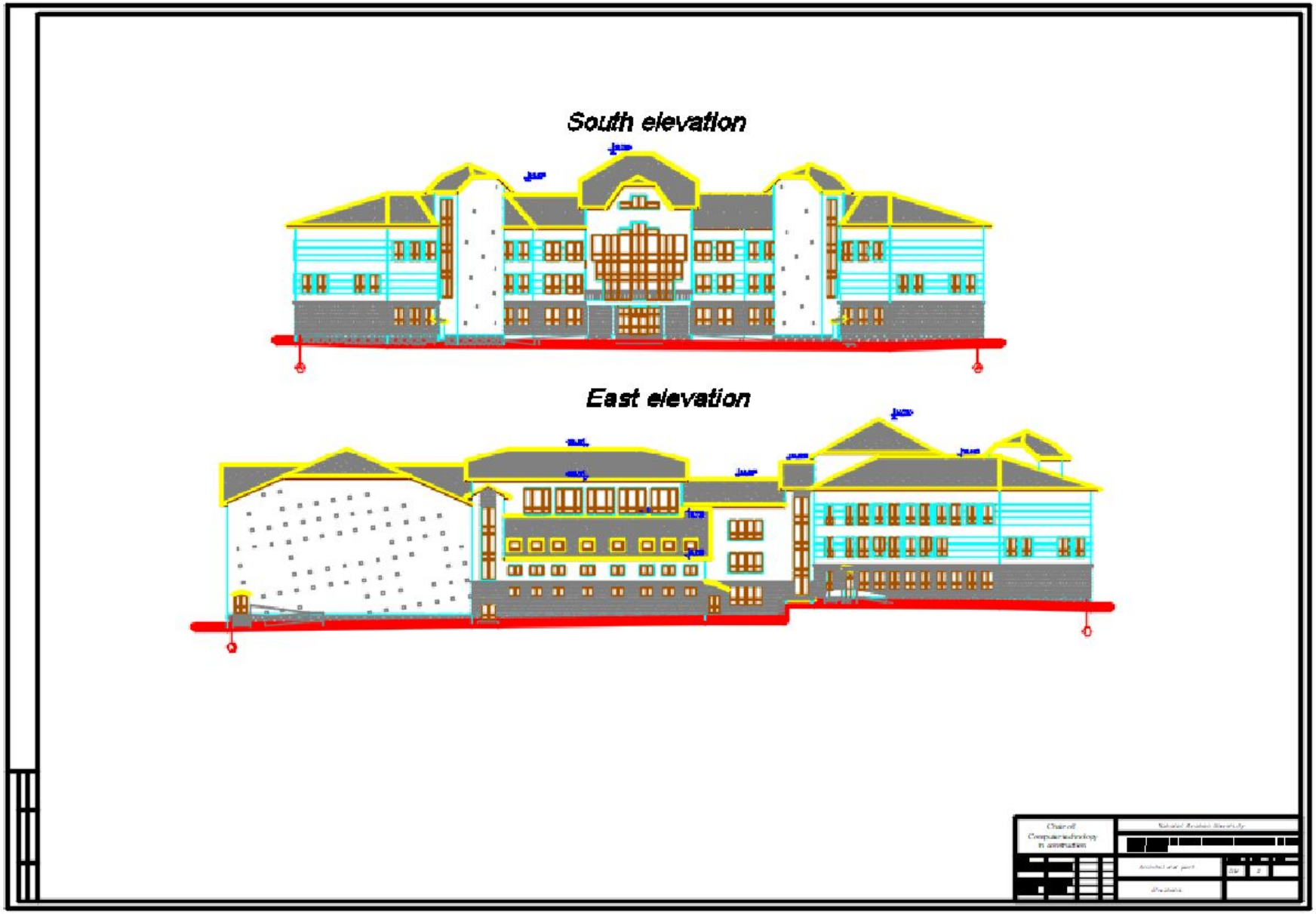
The nature of the distribution of the main vertical stresses in the array of soil at modeling of work of the tape base (loading on foundation 300 kN) at banquets at the level of the sole of the foundation (a) and at the level of soil (b)

Conclusions to scientific research

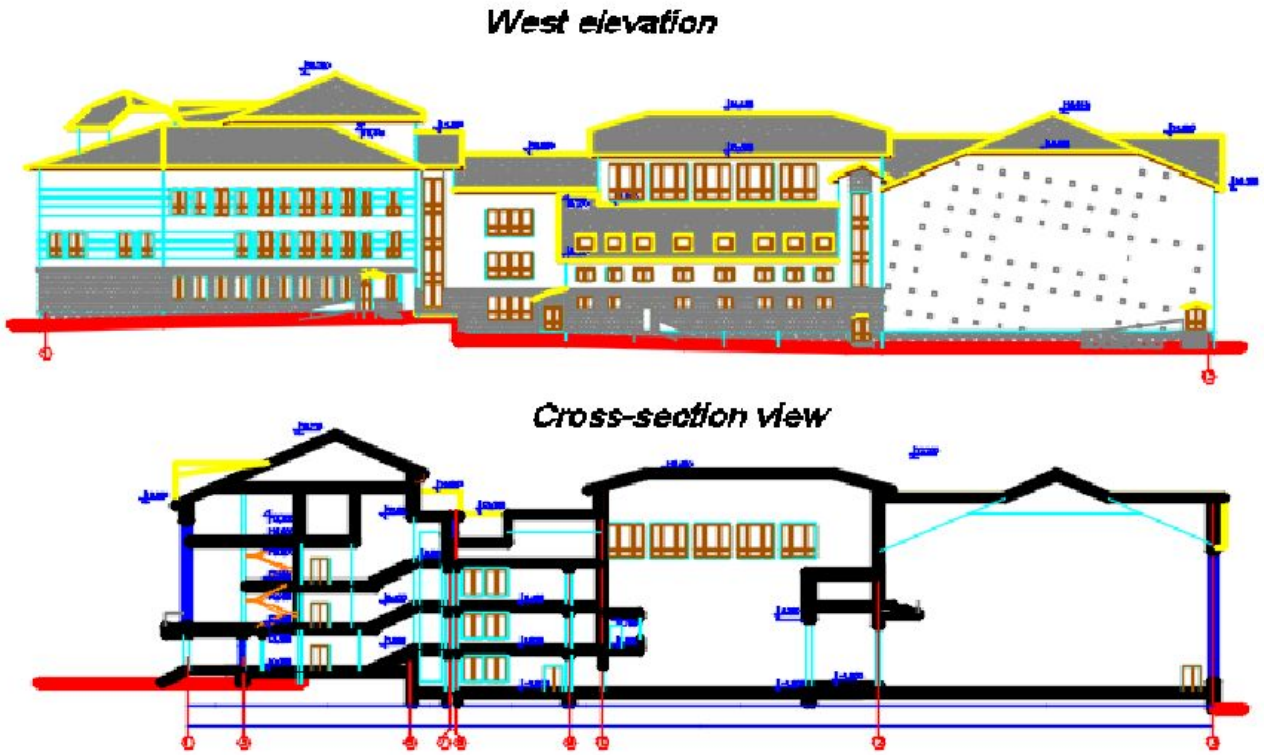
1. When arranging banquets at the level of the soil surface, the soil under the banquet is involved in work at increase in loading that provides effect strengthening.
2. Compared with the option of arranging banquets at the level of the sole, the effect gain is 60% percent.

- **General layout**

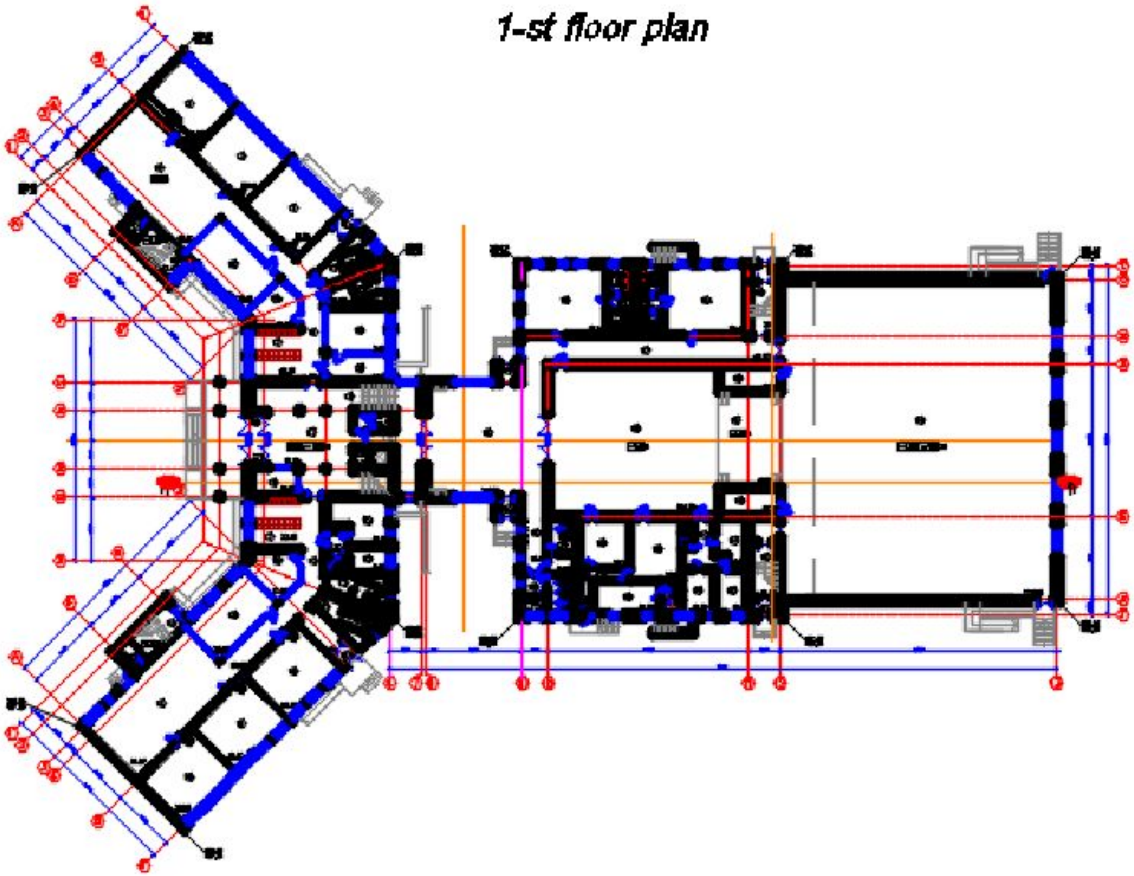
Architectural part



Architectural part



1-st floor plan



Spacification

Pos.	Name	Area sq.m	Notes
	Classrooms 1-5 year of studying		
1	Classroom for elementary	39,80	
2	1st year of study classroom	39,20	
3	2nd year of study classroom	39,20	
4	Recreation room	90,90	
5	Hall	33,80	
6	Tambour	1,80	
7	Wardrobe 1-5 classes	22,50	
8	[illegible] year of study classroom	39,80	
9	[illegible] year of study classroom	39,20	
10	[illegible] year of study classroom	39,20	
	Sanitary rooms		
11	WC girls	14,50	
12	WC Boys	14,50	
13	WC for disable persons	4,80	
14	Hall	3,80	
15	Staircase	12,10	
16	Hall	6,80	
17	Hall	61,50	
18	Staircase	48,10	
19	Guard room	6,50	
20	Elevator's node	2,50	
	Medical rooms		
21	Hall	5,80	
22	Doctor's room	21,10	
23	Isolation room	9,20	
24	WC	2,00	
	Administrative rooms		
25	Reception	14,50	
26	Director room	24,10	
27	The head of director room	15,10	
28	Classroom	17,20	
29	Classroom	17,20	
30	Classroom	15,10	

Pos.	Name	Area sq.m	Notes
	[illegible]		
	Hall	2,00	
	Tambour	146,00	
	Hall	16,80	
	WC	14,00	
	WC	17,00	
	Multyfunctional room	16,00	
	Hall	1,80	
	Lobby	6,80	
	Wardrobe for [illegible]	24,00	
	Dish washing room	22,20	
	Kitchen	28,00	
	Physical training room		
	Lobby	13,00	
	WC	2,50	
	Storage room	13,00	
	Storage room	12,00	
	Storage room	12,00	
	Stage	49,30	
	Training room	278,20	
	Instructor room	11,30	
	Sport equipment store	11,30	
	Locker room	50,90	
	WC	8,80	
	Bathroom	6,50	
	Locker room girls	50,90	
	WC	8,80	
	Bathroom girls	6,50	
	Lobby	62,90	
	Hall	3,60	
	Staircase	12,60	
	Staircase	19,30	

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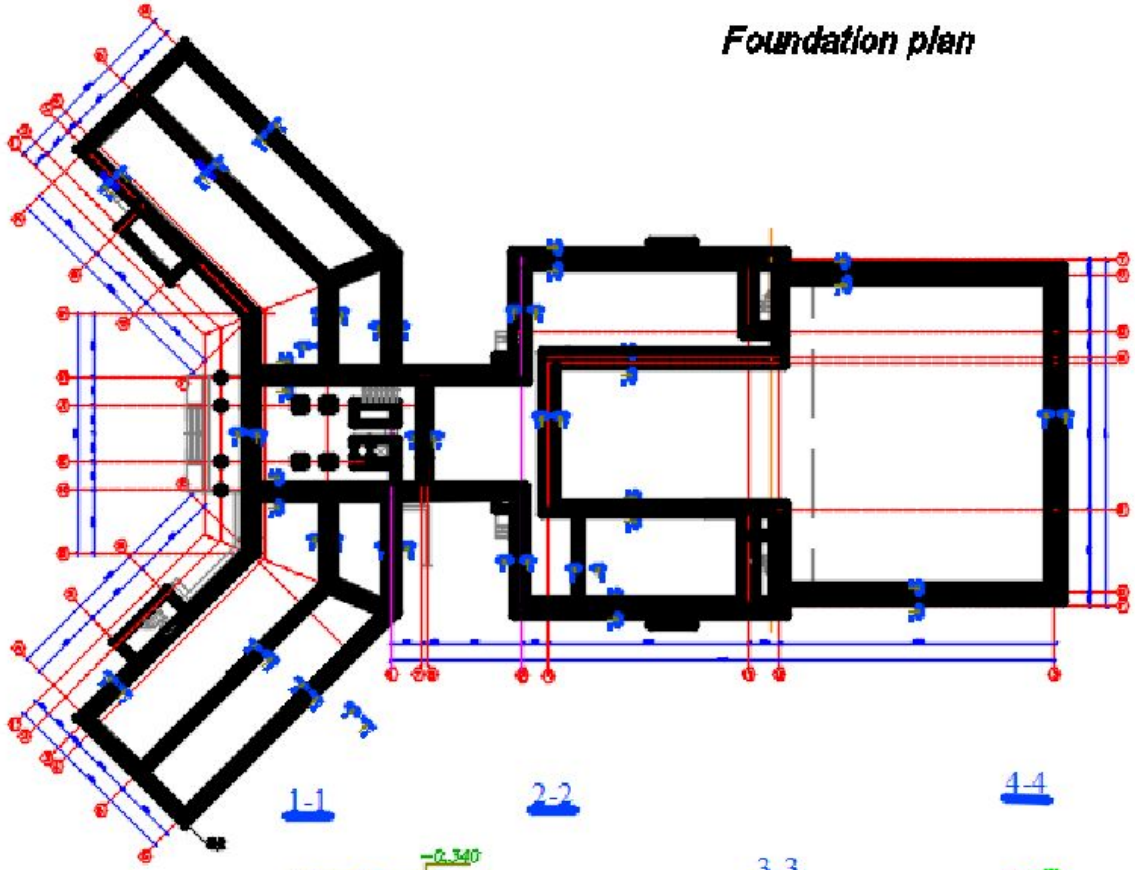
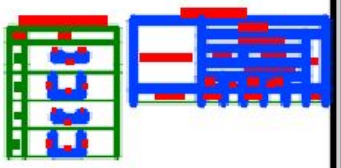
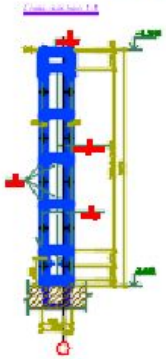
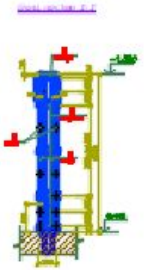
National Aviation University	[illegible]
Architectural part	[illegible]
[illegible]	[illegible]

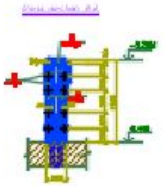
Foundation plan



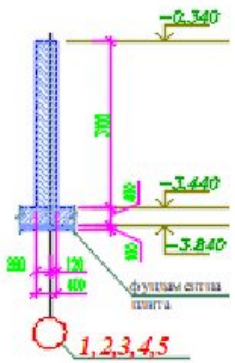








1-1



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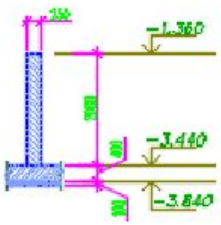

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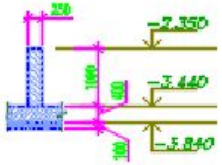

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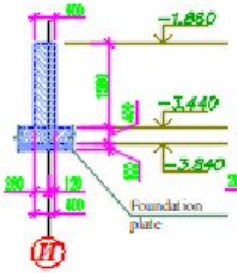

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