MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
FACULTY OF ARCHITECTURE, CIVIL ENGINEERING AND DESIGN
DEPARTMENT OF COMPUTER TECHNOLOGIES OF AIRPORT CONSTRUCTION AND RECONSTRUCTION

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Head of the Department

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BACHELOR THESIS

(EXPLANATORY NOTE)

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Thesis Advisor: O. Rodchenko

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МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ АРХІТЕКТУРИ, БУДІВНИЦТВА ТА ДИЗАЙНУ
КАФЕДРА КОМП'ЮТЕРНИХ ТЕХНОЛОГІЙ БУДІВНИЦТВА ТА РЕКОНСТРУКЦІЇ АЕРОПОРТІВ

ДОПУСТИТИ ДО ЗАХИСТУ
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О.І. Лапенко
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ДИПЛОМНАРОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ БАКАЛАВР

ЗА СПЕЦІАЛЬНІСТЮ 192 «БУДІВНИЦТВО ТА ЦИВІЛЬНА ІНЖЕНЕРІЯ»

Освітньо-професійна програма: «Промислове і цивільне будівництво»

Тема: Житлова будівля в смт Гостомель Київської області

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Завідувач кафедри

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ЗАВДАННЯ

на виконання дипломної роботи

Алдлів Абдалмоула Муфтах Саад

(П.І.Б. випускника)

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Завдання прийняв до виконання: ______________ Алдлів А.М.С.

CONTENTS

INTRODUCTION

Significant changes have occurred since the introduction of market relations. The housing market began to function, and the structure of housing stock by forms of ownership has changed. However, the housing crisis persists. The essence of the housing problem is that there is still a severe shortage of housing that meets regulatory and consumer requirements.

There are three critical aspects to this problem:

- the housing deficit;

- the quantitative aspect;

- inconsistency between the housing stock structure and the demographic structure of the families.

The disparity between the structure of the housing stock and the demographic structure of the families: structural disparity between housing stock and demographic structure of the families; qualitative disparity between available housing stock and consumer quality of housing requirements; operational disparity between available housing stock and consumer quality of housing requirements.

In Ukraine's cities, there is an average of 18 square meters per person. Many families live in communal flats with less than 9 square meters per person.

At one time a home was defined as a place where a family resided. A home is now considered a place where one or more people live, a private place to which they have legal right and where strangers may be excluded. It is the place where people keep their belongings and where they feel safe from the outside world. For housing to be considered a home, it should be permanent with an address. Furthermore, in the best of circumstances a home should not be substandard but should still be affordable. Many people would agree that a place to call home is a basic human right [16].

According to Mary Cunningham and Sharon McDonald in Promising Strategies to End Family Homelessness, research indicates that the primary cause of most homelessness is the inability to pay for housing, which is caused by some combination of low income and high housing costs. Even though many other factors may contribute to homelessness, such as a low level of educational achievement or mental illness, addressing these problems will seldom bring someone out of homelessness by itself. The underlying issue of not being able to afford housing will still need to be addressed [16].

CHAPTER 1. ANALYTICAL REVIEW

A multi-storey apartment building is a building that has multiple storeys, and typically contains vertical circulation in the form of ramps, stairs and elevators [15].

Classification of multi-storey buildings includes [15]:

- ❖ Low-rise: a building which is not tall enough to be classified as high-rise.
- ❖ Mid-rise: buildings of five to ten storeys, equipped with elevators.
- ❖ High-rise: more than 7 to 10 storeys.
- ❖ Skyscraper: 40 storeys or more.
- ❖ Supertall: exceeding 300 m.
- ❖ Megatall: exceeding 600 m.

Structural types:

The following are the basic types of multi-story structures [15]:

- Framed structure

Network of columns and connecting beams form the structural 'skeleton' of the building and carry loads to the foundations.

- Propped structure

Uses a cantilever slab or platform as the seating for columns. It utilises an internal core and external propped columns.

- Suspended structure

Has an internal core and horizontal floors which are supported by high-strength steel cables hung from cross beams at the top.

- Cantilever structure

Has an internal core from which beams and floors cantilever. This removes the necessity for columns.

- Shear wall structure

Composed of stiff braced (or shear) panels which counter the effects of lateral and wind pressures. The pressures are transmitted to the shear walls by the floors.

- Core structure

Utilises a stiff structural core which houses lifts, stairs, and so on. Wind and lateral pressures are transmitted to the core by the floors.

- Hull core structure

Also known as ‘tube-in-tube’ and consists of a core tube inside the structure which holds services such as utilities and lifts, as well as a tube system on the exterior. The inner and outer tubes interact horizontally as the shear and flexural components of a wall-frame structure [15].

- Braced structure

Bracing is used to give stability so that columns can be designed as pure compression members. The beams and columns that form the frame carry vertical loads, and the bracing system carries the lateral loads. Braced frames reduce lateral displacement, as well as the bending moment in columns, they are economical, easily erected and have the design flexibility to create the strength and stiffness required.

Multi-story buildings, depending on their height, may have special considerations and requirements in relation to [15]:

Access and circulation [15]:

In terms of the built environment, the term ‘access’ refers to the means or ability to approach and enter a place, site and so on.

Forms of access may include; doors, escalators, lifts, stairs, ramps, and so on.

The word ‘circulation’ refers to movement around something, in particular a closed system.

In the built environment, this generally relates to the movement of people, typically within a building. Within buildings, circulation spaces are spaces that are predominately used for circulation, such as entrances, foyers and lobbies, corridors, stairs, lifts, landings and so on.

Fire safety and evacuation:

Buildings need to be designed to offer an acceptable level of fire safety and minimise the risks from heat and smoke. The primary objective is to reduce to within acceptable limits the potential for death or injury to the occupants of a building and others who may become involved, such as the fire and rescue service, as well as to protect contents and ensure that as much as possible of a building can continue to function after a fire and that it can be repaired. The risk to adjoining properties also needs to be considered, as well as possible environmental pollution [15].

Building evacuation is the process of making sure everyone inside a building gets out safely and in a timely and controlled manner in the event of an emergency, such as fire. Buildings commonly use equipment such as fire alarms, exit signage, emergency lighting and emergency escape routes to facilitate evacuations [15].

Structural design [17]:

The structure of a building (or other built asset) – whether framed or non-framed – concerns those parts that are fundamental to its strength, stability and rigidity and which transfer the various loadings (including their self-weight) down to the foundations. This comprises loadbearing or structural primary elements. Structural design is therefore the process of creating a safe, efficient structure in which loads are conveyed safely and efficiently to the foundations and which can withstand prevailing natural forces.

Ventilation is necessary in buildings to remove 'stale' air and replace it with 'fresh' air [17].

This helps tomoderate internal temperatures.

Reduce the accumulation of moisture, odours and other gases that can build up during occupied periods.

Create air movement which improves the comfort of occupants.

Shading, views and right to light:

Solar radiation can be useful in providing natural light and heat for buildings, reducing the need for artificial lighting or heating. This can reduce energy use and so emissions. However, excessive solar radiation can result in overheating, which may need to be countered with energy-intensive cooling, or can cause glare, a form of visual discomfort experienced when lighting is excessively bright.

In terms of the built environment, the term ‘view’ refers to a visual prospect of, or from, a structure or building. A view from a building is generally enabled by installing a window or other form of opening or external platform [17].

Having a ‘good view’ is typically seen as an desirable quality for buildings and is often one of the factors that affects its price. Equally, a ‘bad view’ can have a negative influence [17].

Rights to light generally become an issue when a new development, or proposed development affects the access to light of an adjoining property. Rights to light also apply to obstructions caused by trees, hedges and so on, but there are no rights to light for open ground [17].

Construction methods are the procedures and techniques that are used during the building process.

Maintenance is the process of ensuring that buildings and other assets retain a good appearance and operate at optimum efficiency. Inadequate maintenance can result in decay, degradation and reduced performance and can affect heath and threaten the safety of users, occupants and others in the vicinity [17].

Depending on its design, quality of materials and workmanship, function and location, buildings deteriorate at different rates and require different levels of attention. No building will ever be maintenance-free, but the quality of the design and workmanship can minimise the level required [17].

Maintenance can help [17]:

- prevent the process of decay and degradation;
- maintain structural stability and safety;
- prevent unnecessary damage from the weather or from general usage;
- optimise performance;
- help inform plans for renovation, refurbishment, retrofitting or new buildings;

- determine the causes of defects and so help prevent re-occurrence or repetition;
- ensure continued compliance with statutory requirements.

For an engineer who is new to designing multi-storey buildings it is important that they follow a logical sequence through the various stages of the design process. Six steps that define this sequence are described below. Rules of thumb are included within each step to help the designer quickly and efficiently arrive at a solution that is sensible for a given set of constraints. In addition, it is important for the designer to understand some overarching principles of good design – so that the result is not only sensible but is also ‘good’ [17].

Stages of a project [17]:

The stages of a construction project are presented in ISE publication ‘Structural design – the engineer’s role’which may be broadly summarised as follows:

- project formulation - What it’s for, why is it being proposed, where is it, etc;
- assembling the data and developing the brief - Understanding the site and context;
- scheme design - looking at and developing options;
- detailed design - Of the various components and elements;
- information for construction - Drawings, specifications.

Construction

Many of these stages include aspects of engineering design. A characteristic of steel framed construction is that the constituent parts of the structure are manufactured off-site, with all the quality and speed-on-site benefits that are associated with such a form of construction. An implication of this, however, is that the design must be substantially complete before construction (steelwork fabrication) can begin. It is therefore important that the designer follows a logical sequence, as going back and revisiting earlier design decisions, once other parties involved have moved on to designing other parts of the building or manufacturing components, can be disproportionately expensive [17].

Some basic choices may have a significant impact on the ease, time and cost of both the fabrication and construction of a steel framed multi-storey building. Keeping fabrication and construction in mind from the start will lead to the best possible solution. The designer should also avoid over-specification, a trivial example being that corrosion protection is not needed when steel components are used in many internal environments [17].

Lowest weight may not be best.

The impact of steel weight on building cost is interesting as there are conflicting drivers. Some things are quantifiable – in many countries labour is more expensive than materials so adopting a larger steel section rather than one that needs labour intensive fabrication, for example of stiffeners, can be more cost effective. Against this argument, using more material may be associated with greater embodied energy and carbon. But the considerations are more complex than that because thicker plates also have greater resistance, for example to localised buckling, so the use of larger sections may [17]:

- improve resilience under accidental loading, making them particularly appropriate for key elements to assure the robustness of a structure against unforeseen circumstances.
- facilitate design for temporary load conditions, this avoiding the need for additional temporary elements/sub structures during erection.
- permit deliberate over-design, to facilitate change of use in the future and so extend the lifecycle of a structure.
- require less fire protection (because heavier sections have greater surface area/volume), saving on both materials and cost.

Standardise:

Closely related to familiarity is standardisation. Although the use of standard member sizes is less important than it used to be, given modern ways of modelling and fabrication, there may still be benefit in reducing the number of different member sizes used on a project. This desire for standardisation goes right down to the steel grade and bolt grades and sizes [17].

Rolled sections should only be specified in grade S355 steel (or higher grade) steel to ensure availability as well as performance benefits. However, for the fittings (plates used for connections etc.), many steelwork contractors prefer grade S275 steel. Again, a key is to avoid mixing steel grades for components that look otherwise identical as this facilitates quality assurance [17].

One of the main areas where standardisation is beneficial is the joints . The use of standard joints means the design process is greatly simplified, for example because resistances are tabulated or software can be used more effectively, and the detailing will be acceptable to those who will fabricate and erect the steelwork – standardisation, simplicity, familiarity [17].

Standard beam-to-column and beam-to-beam simple joints adopt one of the three following options, each with its own particular advantages and areas where it is less appropriate [17]:

Fin plates – particularly good from an erection point of view.

Partial depth end plates – better than fin plates for connections to column webs.

Full depth end plates – particularly good for temporary stability and offer significantly greater tying resistance (for robustness) than partial depth plates.

The design process:

Six steps are chosen to split the design process into a logical sequence from early scheme design consideration through to detailed design. They cover [17]:

Step 1: Initial design considerations

Building specific requirements:

The basic building shape will normally be chosen, or at least heavily influenced, by other members of the design team. It will often be dictated by site restrictions, be they physical or regulatory such as planning restrictions. Before developing this basic shape into a design the engineer should make sure he/she is aware of any project specific requirements.

Number of floors [17]:

To achieve maximum lettable floor space the design should balance the number of floors against floor-to-floor height, paying attention to the intended building use.

Shallow floor systems can be helpful for a designer trying to achieve the right balance. Although they tend to have a higher cost per unit area, the reduced floor depth may provide the designer with:

- more flexibility to achieve the best compromise between floor-to-floor height, number of floors, and overall building height;
- a means to reduce building envelope area/cost;
- a means of reducing operational carbon by reducing heat loss through the envelope.

Stability system:

The resistance of a steel frame against horizontal loading can be achieved in a number of ways. The most appropriate choice depends on the scale of building:

- for low rise buildings steel bracing is normally used.
- for medium rise buildings (5 to 15 storeys) either concrete or braced steel cores are used.
- for high rise buildings the use of a concrete core facilitates the construction process as the core assures stability as steelwork erection progresses up the building, tied back to the core.

Step 2: Choice of grids [17]:

Having recognised any building specific requirements, decided on the most appropriate number of floors and, in general terms, how the frame will be stabilised against horizontal loading, the designer should start to consider in more detail how the frame will be laid out. The structural grid is defined principally by a regular spacing of columns, with the primary beams spanning between columns, secondary beams spanning between the primary beams, and floor slabs spanning between the secondary beams. Wherever possible the beams are laid out in an orthogonal arrangement to provide rectangular floor plates as this arrangement enables simple orthogonal connection details between beams and columns to be adopted.

Step 3: Preliminary sizing [17]:

Once the grids are established it is possible to estimate preliminary sizes of the beams using some rules of thumb for span to depth ratios.

At this step "Preliminary sizing" , we estimate the size of [17]:

- floor slabs and beams.
- columns.
- bracing.
- weights.

Step 4: Analysis:

Determining the loads:

Before the frame can be analysed and the structural members designed it is necessary to determine the magnitude of loads and other actions such as thermal movements, which may result in stresses in the structure. The main load types are the self-weight of the structure (and non-structural components), imposed floor loadings, environmental loading including wind and snow, and induced additional loads caused by frame imperfections and sway [17].

Determining the internal moments and forces:

Once the loads and preliminary member sizes have been identified, the structural analysis can be carried out. This process results in calculation of the internal moments and forces the frame members must be able to resist (against which the preliminary sizes can be checked and the design refined) [17].

Step 5: Element design:

Having determined the moments and forces in the frame members and joints it is possible to move on to detailed design. when a frame is continuous it may be necessary to undertake some iteration because the size of the members affects the moments and forces that are attracted to themselves and their neighbours [17].

Step 6: Other checks:

In addition to checking the frame members for gravity, imposed and wind loads, some other verifications must also be made as they could affect the final size of the members and joints. These other checks include, but are not restricted to, checking for sway sensitivity, fire performance, robustness and acoustics performance [17].

CHAPTER 2. ARCHITECTURAL DESIGN

Initial data:

1. Construction area: Gostomel
2. Purpose of the house: multy-storey apartment building.
3. Surface of the construction site: horizontal.
4. The subsoil consists of: sandy clay, sand.
5. Groundwater level below the planning mark of the site: -5,5 m
6. Groundwater in relation to concrete: -4,45 m
7. Dimensions of axis (“1”-“2” 1.5 m) (“2”-“3” 3m) (“3”-“4” 4.5m) (“4”-“5”2.1m) (“5”-“6”2.1m) (“6”-“7”4.5m) (“7”-“8” 3m) (“8”-“9” 1.5m).
8. Length of the apartment building: 22.2 m.
9. Dimensions of axis “A”-“B” 6.0 m, “B”-“C” 4.5 m, “C”-“D” 4.5 m, “D”-“E” 1.5 m.
10. Height of the apartment building is 34.7 m.
11. Material of load-bearing structures: monolithic reinforced concrete.
12. Type of roof of the house: Flat.
13. Roof of the house: flat roof.
14. Exterior walls of the apartment building: multilayer partition wall.

Number of floors: The apartment building incliudes 9 floors.

Number of single-room apartments is equaled 16. Area of the single-room apartment is 54,28 m^2. Total area of the single-room apartments is equaled 868,48 m^2.

Number of double room apartments is equaled 16. Area of the double room apartment is 77,85 m^2. Total area of the double room apartments is equaled 1245,6 m^2.

Total area is equaled 2114,08 m^2.

Structural model of the apartment building - monolithic reinforced concrete frame. The height of the ground floor is 3.3 m, the height of the typical floor is 3.3 m, too.

Load-bearing structures are monolithic reinforced concrete structures:

- pylons with dimensions of 250x1000 mm, concrete C25/30, reinforcement A400C and A240C (DSTU 3760: 2019),

- the slab has a thickness of 200 mm, concrete C25/30, reinforcement A400C and A240C (DSTU 3760: 2019),

- walls have a thickness of 200 and 250 mm, concrete class C25/30, reinforcement A400C and A240C (DSTU 3760: 2019),

- borehole reinforced concrete piles with a diameter of 420 mm (concrete C20/25, reinforcement A400C and A240C (DSTU 3760: 2019), united by mat foundation with thickness value of 1200 mm (concrete C20/25, reinforcement A400C and A240C (DSTU 3760: 2019).

Structural scheme of the apartment building: frameless with load-bearing brick walls.

Facade – contact facade system, wall insulation with mineral wool with thermo physical characteristics that provide the normative resistance to heat transfer.

Walls:

- external – ceramic brick 250 mm
- inter-apartment and inter-apartment corridor – ceramic brick;
- anterooms – ceramic brick;
- balcony's – fencing in accordance with the passport of the facades.

Overlapping: reinforced concrete slab 200 mm.

Roof: flat roll with internal drainage, insulation mineral wool boards with thermo physical characteristics that provide the normative resistance to heat transfer.

Characteristics of fire-fighting measures: common areas and apartments equipped with a fire alarm system – according to the project.

Smoke protection: - smokeless stairwell; availability of fire water supply on each floor; common areas are equipped with fire automation; in each apartment, in a bathroom the fire-prevention crane set is provided.

Number of elevators: 1 modern high-speed elevator.

Typical floor height: 3.30 m (floor to floor).

Filling slots:

- entrance doors to the house – aluminum profile systems;
- doors in public places – metal with the appropriate limit of fire resistance and/ or metal-plastic;
- entrance door to the apartment – metal, shockproof with a limit of fire resistance in accordance with the current regulatory documentation, decorated with MDF and fittings;
- internal doors in apartments – are not established;
- windows: wooden, externally laminated or painted in accordance with the passport of facades profile systems such with energy-saving glass and two-chamber double-glazed windows.

Accessories with micro ventilation function:

- windows between the room and the loggia with glazing: metal-plastic profile systems with single-chamber double-glazed windows. Accessories with micro ventilation function.

Floor installation – cement-sand screed, in bathrooms and toilets – waterproofing according to the project;

Staircase – smokeless; lighting of stairwells type H-1 – natural and artificial; availability of fire water supply on each floor; common areas are equipped with a fire alarm system.

Elevator: cargo-passenger 630 kg (for residents of the apartment building).

Heating system: home heating - central. Horizontal wiring in the apartment – polyethylene pipes of REHAU firm or similar.

Type of heaters: metal radiators.

Cold and hot water supply system: cold and hot water supply system – centralized. Branching from risers of cold, hot water and the sewerage to sanitary appliances is not present is performed.

Installation and placement of all types of meters:

- electric meters – apartment by apartment with their installation in the transit corridor;

- cold and hot water metering – apartment and house;
- heat and heating metering – apartment by apartment with installation of meters in the transit corridor and general house.

Sewerage system:

- risers – plastic pipes located in bathrooms;
- branching from sewer risers to plumbing fixtures is not performed.

Power supply:

- wiring of copper wire with the installation of three-phase meters located in the public corridors of each floor;
- apartment-based electrical panels located in the corridor of each apartment.

Public places:

- entrance group – decoration according to an individual design project;
- Ground floor hall, corridors, stairwells, elevator halls and other technical rooms.

– decoration in uniform style according to the design project.

Landscaping:

- external lighting and small architectural forms according to the project;
- roads, sidewalks, paths – asphalt concrete and from final element model.

Space planning is an important part of building design and is used to determine how a space (or spaces) should be laid out and used. It may be undertaken as part of the building design process, or as a stand alone exercise looking at how best to plan an existing space, or a space that is being developed. It can be used for very simple spaces such as hotel bedrooms, through to very complex industrial buildings.

Good space planning can improve the wellbeing and productivity of the occupants of a space. Designers will consult with the client to clarify their requirements for the space before starting planning (and perhaps assess existing spaces), typically by considering issues such as:

budget and time constraints;

the separation of activities into zones; the intended use of the space;

the number of occupants;

the space required per occupant; the main focal points of the space;

the need for availability of windows and doors;

access into and from the space, and the function of adjacent spaces; circulation within the space;

access and use of the space for people with disabilities; the requirement for furniture, fixtures and fittings;

the number of people who are likely to use the space;

whether the space should be balanced and symmetrical, unbalanced or a combination;

security, safety and privacy;

legislative requirements;

lighting IT and other building services requirements;

energy targets and sustainability requirements;

environmental requirements, such as noise, lighting, ventilation, temperature, and so on;

environmental controls;

welfare facilities;

views, color’s and branding;

planting;

the need for flexibility or future growth;

Apartment building model was created by using building information modeling software (BIM) Archicad 25 (fig. 2.1).

By allowing the automatic application of pre-defined rules to the entire space, parametric modeling can simplify space planning. For example, if the color scheme for a specific area of the space is changed, every object with that color attribute will change as well. Other parameters could include positional data, dimensions, form-describing algorithms, and so on. In particularly complex spaces, techniques such as space syntax can enable detailed simulation and investigation of the relationships between spatial layout and human behavior.

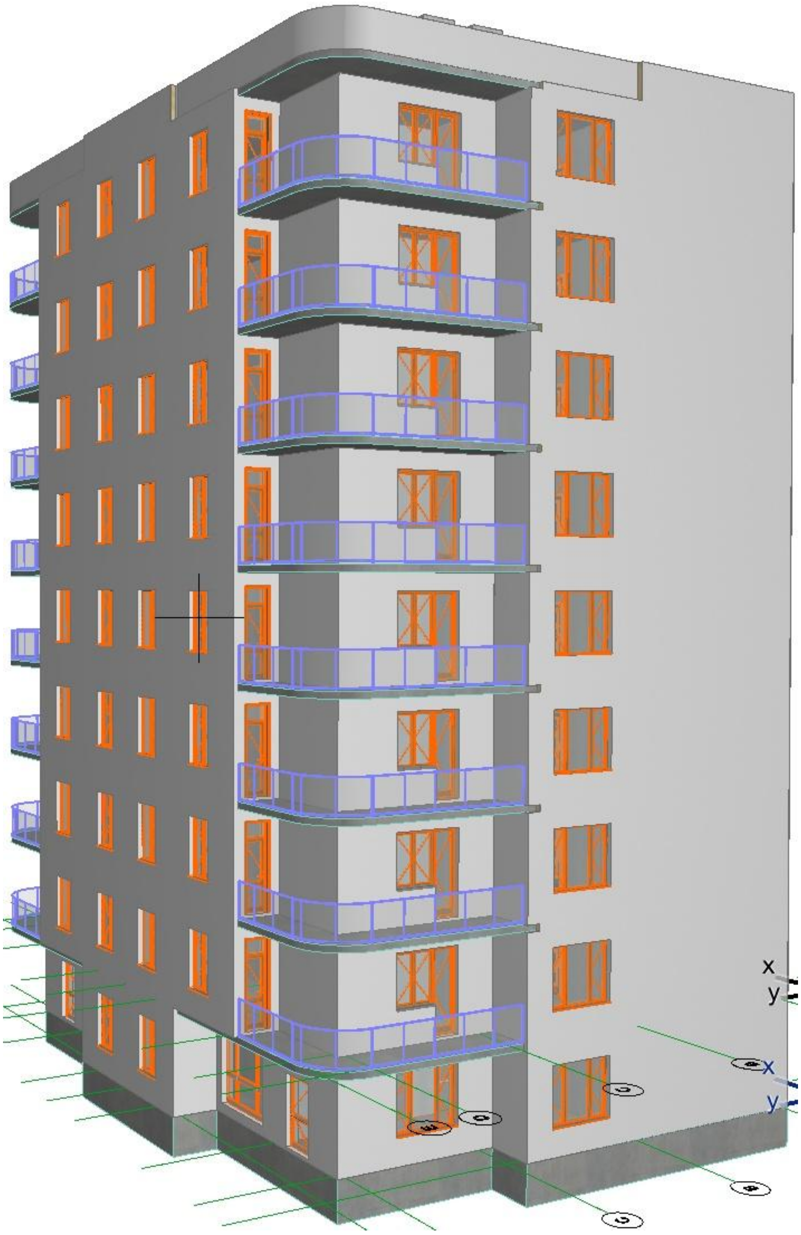

Fig. 2.1. Building information model of the apartment building in Archicad 25

This could be useful in the design of a station where a large number of competing uses occupy the same space, for example. In its broadest sense, the term "decoration" refers to the process of making something more appealing, or to the items used to make something more appealing. Decoration in the construction industry refers to the "dressing" of a room or interior space. It is also known as "interior decoration" or "decor," and it refers to the aesthetics of a space and its furnishings, furnishings, surface finishes, lighting, and so on.It does not usually include the shape of the space, the position of the walls, and so on. The goal of decoration is to make the space more aesthetically pleasing and functionally useful for the occupants, but it may also take into account larger contextual issues such as fashion, culture, and so on. In a domestic setting, decoration can be done by the homeowner (DIY) or by hiring tradespeople (such as a painter and decorator). A professional interior designer (or another designer, such as an architect) may be responsible for designing decorations on higher-value projects, and their role may extend beyond this to include the layout and use of the space.

The organization ofinternal spaces to the externally visible form, the composition of a residential structure, which is established on the basis of a logical functional solution, is built from the inside out. The opposite way – from a preconceived form of volume – almost inevitably leads to a conflict between functional and aesthetic requirements, a contradiction between functional and aesthetic rules.

Depending on the technique to shaping the interior space of the building, there are two primary approaches of constructing the volume shape of a building.

The first and most conventional way emphasizes the system's components, including a clear division of all rooms into homogenous functional groupings, a core of composition, and functional links and aspects of a functional relationship. Each of these is split into its own section of the volume, with the functional connections' elements serving as ties between them.

The internal space parameters in this situation are identical to the system of living organization in the building, resulting in a unique type of planning structure. Internal spaces can be joined horizontally and vertically depending on the function and size of the area. The single-family house's complicated volumetric form is typical of modern and organic architecture.

The structure of communication spaces (corridors, halls, staircases, and mezzanine) should be transparent and understood.

The second method of constructing the building's volume form is more in line with modern architectural requirements, based on the formation of a single, maximum generalized form of the house with a simple outline of the volume through versatile and varied use of internal space by creating consolidated, flexible space. Internally, the area is divided into functional groups using features that are not part of the building's core construction, such as sliding walls and furniture. It creates adaptable spaces, allows for different applications, and extends the life of the structure. However, the building's function is difficult to describe due to its extraordinary generality of form.

In modern mansions and villas, the form is abstract and unrelated to tradition, and one can hardly recognize a home. In conventional or classical mansion architecture, this is not the case.

The decision to use one method over another is based on specific functional and artistic goals as well as the environment. The first way is most effective when the needs of functional process isolation and certainty predominate, as well as a wide plot area; the second method is recommended when the requirements of functional process diversity, blurring of forms and borders, and plot space are limited. In some circumstances, both strategies are employed simultaneously while developing residential buildings. The link of the residential building to the outside world distinguishes the primary types of spatial composition.

A closed plan indoors creates a connection to the building's exterior. In an enclosed composition, the structure is formed around the connection between the exterior and the interior. The internal spacesare connected to the external environment via an open space, the atrium, which is included in the structure.

The entry led to a closed courtyard, which was open to all of the house's and outbuildings' rooms. The courtyard provided light and fresh air to the residence. In an urban setting when space is limited, the enclosed composition is advantageous.

In hot, dry climes, and in urban dwellings where narrow plots make visual and acoustic insulation crucial, the enclosed composition is useful. The rooms of the house are clustered around the main, central one in a centric composition. The building's interior spaces are subordinated to the inner core - an overlapping, overhead-lit room, as in the preceding composition. Villas and palaces use the central composition. In basilica design, the structure has a central spatial core that develops in one plane. With windows in the upper section and on the side walls, the inner opens up towards the middle or side of the uppermost room.

This type of composition was developed in Romanesque and Gothic architecture. The basilica composition is the basis of the traditional American settlerdwelling (solt box), can be applied to an exclusive dwelling, or used as an element of a complex composition.

The first and most important factor in determining the quality of a home is its rationality. The arrangement and composition of the rooms are the most important factors in determining the quality of a home. Living quarters and auxiliary rooms are the two types of rooms in a house. The rooms are merged into a single group. The arrangement of rooms in a house allows a natural flow of life. The content of rooms in a townhouse is more complex than that of a flat in a high-rise structure since the entire volume of the building is used. City home, since the full volume of the structure is used, including the cellars, allowing for significant cost savings despite the plot's limited size.

The house's architectural and planning structure reflects the owner's social position as well as the demands of the tenants. The front of the home features a porch with a canopy or canopy, as well as a vestibule. The entrance hall, lobby, and hallways serve as a buffer between the street and the home proper, as well as a space for guests to greet, undress, and tidy up. They also serve as a link between rooms on the same floor, as well as a location to convert rooms into something else on the same floor. The living room is a space where visitors are welcomed, business meetings are held, and special occasions are celebrated at home. The kitchen is a place where you can prepare food.

Dining area — this is where meals for a family of three or more people are served. The office is a place where family members can work and business discussions can take place. A family room serves as a gathering place for family members to engage in common activities and unwind. The bedroom, which is divided into a parent's bedroom and a child's bedroom, is a relaxing space for family members. A collective hygiene space is the sanitary unit. Garage - an area for storing vehicles that is usually found on the ground floor of a home.

Household duties, garage labor, or family interest activities can all be done in the workshop. Utility rooms are areas where heating and water systems are installed and entered, as well as fuel storage. Seasonal items, utensils, and consumables are stored in storerooms and cloakrooms.

Attic – utilized for residential or other uses, attic space allows you to greatly increase the overall area of your home without dramatically increasing the price. Summer quarters — verandas, terraces, and balconies – are both utilitarian and architectural parts of the house. The layout of the rooms in the house can be altered to suit the needs of the customer. Each adult member of the family should have his or her own room.

Analyzing the social and domestic duties that a person performs in the course of his or her life justifies the lowest amount of living space. A person requires floor space and adequate equipment to do these tasks. The amount of space taken up by equipment (furniture, etc.) and storage space is also calculated. The amount of floor space taken up by equipment (furniture, for example) and breathing room is also calculated. The following spaces are recommended in living areas: sleeping and resting places, eating areas, family recreation areas, individual exercise areas, and hygiene areas.

The minimum living space a person needs is rationed according to the size of the family. For instance, all the above-mentioned functional areas require a minimum of 14-15 m^2 floor space for a one-person family, and 20-25 m^2 for a two-person family.

Based on the principles of satisfying all basic physiological and psychological needs of a person, the following should be recognizedas reasonable: a separate room for each adult member of the family each adult family member a separate room; optimal size of the living space per person 18 m^2;

The permissible gross floor area per person 28 - 30 m^2; an optimum living space height of 3 meters.

A home that fits these criteria will considerably contribute to a healthy living. On the basis of the foregoing, it can be concluded that a "healthy dwelling" should be defined as a dwelling unit with a layout design based on functional zoning, sufficient floor space per person and a separate room for each adult family member, all types of amenities, providing thermal, air, light, visual, and acoustic comfort, a landscaped communal area with a hygienic arrangement of the outdoor space, and a proper living environment.

Hygienic standards must be met in the area. Currently, many countries have distinct forms of living space norms. Different countries have different standards for floor space, such as a minimum amount of living space per person, or different countries have different standards for living space, such as a minimum floor area for a single person and a floor area for houses with various numbers of rooms, or living space based on the number of family members.

The specification of minimum floor space needs, based on European standards, is of interest, as the quality of the residence is determined by the number of bedrooms rather than the number of rooms. A bedroom is a space that has direct access to a bathroom and toilet. A regular bedroom, a bedroom as a shared room, and a children's bedroom are the three most common options for bedroom design. The conventional bedroom is defined as a space used solely for sleeping.

The calculations, which take into account the location of modern furniture as well as free space along the main utility lines, yield a floor space of around 20 m^2 for a square-shaped bedroom. In the event that the dimensions deviate from the square shape, they must be raised by 20%. Bathroom and toilet are merged into a single sanitary unit, which must include a bidet, according to the Eurostandard. In addition, the unit is 8 m^2 in size due to the necessity for a storage container for sanitary amenities. As a result, a modern bedroom with a sanitary unit requires 28 m^2 of floor area for living space.

Gostomel is located in Kyiv region (Fig. 2.2).

In Gostomel, the summers are comfortable and partly cloudy and the winters are long, freezing, snowy, windy, and mostly cloudy. Over the course of the year, the temperature typically varies from -7°C to 26°C and is rarely below -17°C or above 32°C.

Calculation of thermal insulation:

Fig. 2.2. Ukraine temperature zone

1. Determine thermal resistance of multilayer wall

$$R_{\Sigma} = \frac{1}{\alpha_B} + \sum_{i=1}^{4} \frac{\delta_i}{\lambda_{ip}} + \frac{1}{\alpha_з} = \frac{1}{\alpha_B} + \frac{\delta_1}{\lambda_{1p}} + \frac{\delta_2}{\lambda_{2p}} + \frac{\delta_3}{\lambda_{3p}} + \frac{\delta_4}{\lambda_{4p}} + \frac{1}{\alpha_з} \geq R_{q\,\min},$$

Where R_{qmin} - permissible minimum thermal resistance,

δ - layer thickness, m

λ - thermal conductivity, W/(m·K).

Gostomel is the first temperature region.

$R_{qmin}$of the external wall equals 3,3 m^{2}K/W.

$\alpha_в$=8,7 Вт/(м^2×K),

$\alpha_з$=23 Вт/(м^2 K).

Determine thermal resistance of multilayer wall:

Layers of the wall:

Plaster - Lime Sand - 10 mm.

Insulation - Mineral hard - 120 mm.

Brick - 250 mm.

Plaster - Gypsum - 10 mm (Fig. 2.2).

$$R_{\Sigma} = \frac{1}{8.7} + \frac{0.01}{0.70} + \frac{0.12}{0.038} + \frac{0.25}{0.81} + \frac{0.01}{0.19} + \frac{1}{23} = 3{,}69 \geq R_{q\ min}$$

Thus recommended value of insulation (Mineral hard) thickness equal 0.12 m or 120 mm.

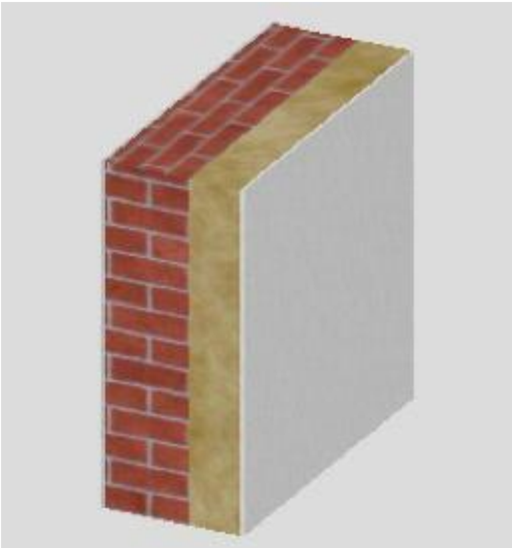

Fig. 2.3. Wall cross section

2. Determine the wind direction in the area :

Table 2.1

The repeatability of the wind direction for city Gostomel in January

N	Ne.	E.	Se.	S.	Sw.	W.	Nw.
11.2	4.6	5.8	11.9	14.1	14	23.5	14.9

Table 2.2

The repeatability of the wind direction for city Gostomel in July

N	Ne.	E.	Se.	S.	Sw.	W.	Nw.
18	9.1	4.8	8	11.3	10.4	20.4	18

Based on the data given, it is possible to build a wind rose for the winter, summer or mixed (middle) periods. The average period is required when construction is carried outfor a year or more.

Table 2.3

The repeatability of the wind direction for city Gostomel in average

N	Ne.	E.	Se.	S.	Sw.	W.	Nw.
14.6	6.85	5.3	9.95	12.7	12.2	21.95	16.45

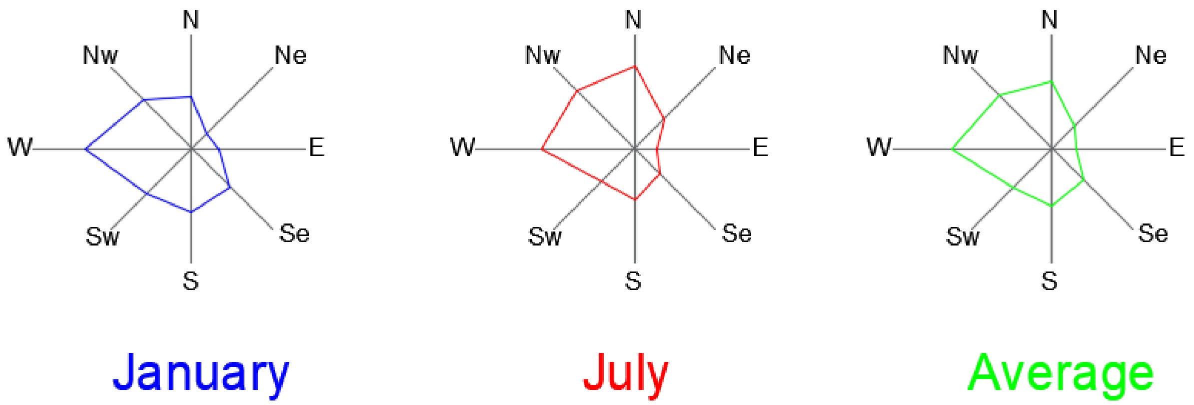

Fig. 2.4. Wind rose in Gostomel

CHAPTER 3. STRUCTURAL DESIGN

We find the characteristic value of the load from the dead weight of the overlap q_0. It is necessary to multiply the specific weight of the overlap γ on its thickness t by using the expression:

$$q_0 = \gamma \cdot t \tag{3.1}$$

Thus, we have the follows

$$q_0 = \gamma \cdot t = 2500 \cdot 0{,}18 = 450\,\frac{kg}{m^2} = 0{,}45\ t/m^2$$

With the help of the norms, we can find out, that ratio of reliability by the limit load γ_{fm} is equaled 1.1.

Estimated load q_m is equaled:

$$q_m = q_0 \cdot \gamma_{fm} \tag{3.2}$$

So, we have $q_m = q_0 \cdot \gamma_{fm} = 0{,}45 \cdot 1{,}1 = 0{,}5\ t/m^2$

Apartment building is a civil building, equipment load is absent, so we must determine only the human load. In the apartments human load is equaled *0,15* t/m^2.

In accordance with the current normative document, the snow load is calculated as a load on the horizontal projection of the flat roof.

Long-term snow load is determined by using the formula:

$$S_p = (0{,}4S_0 - \bar{S})C, \tag{3.3}$$

where $\bar{S} = 160\ Pa = 0{,}016\ t/m^2$;

S_0 - characteristic value of the snow load, which is equal 1550 Pa = 0,155 t/m^2 for Gostomel;

C=1.

Long-term snow load

$S_p = (0{,}4S_0 - \bar{S})C = (0{,}4 \cdot 0{,}155 - 0{,}016) \cdot 1 = 0{,}046\ t/m^2$

Short-term snow load is determined by using the formula:

$$S_m = \gamma_{fm} S_0 C, \tag{3.4}$$

where $\gamma_{fm} = 1$.

So, short-term snow load $S_m = \gamma_{fm} S_0 C = 1 \cdot 0{,}155 \cdot 1 = 0{,}155\ t/m^2$

According to the current normative document, the wind load is calculated as the normal pressure applied to all surfaces of the structure located in the wind flow.

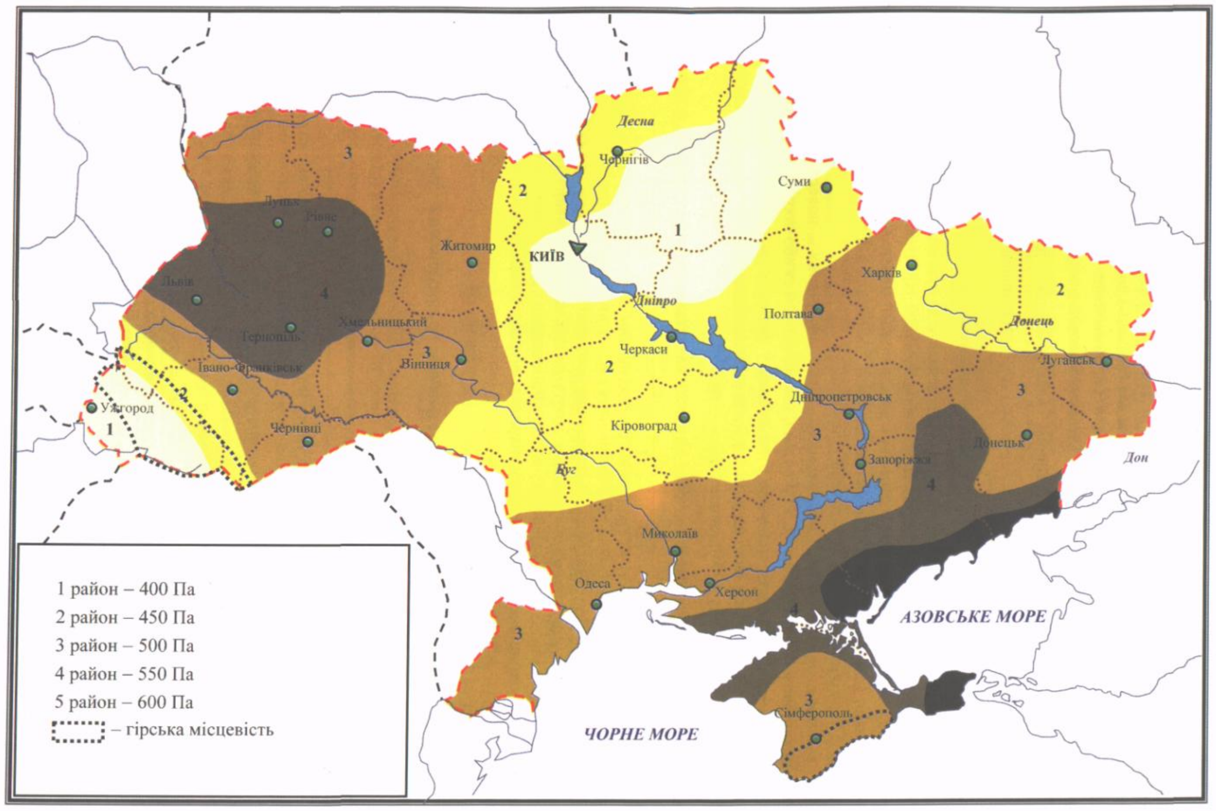

Fig. 3.1. Zoning map of the territory of Ukraine according to the wind pressure

Gostomel belongs to the first region (wind pressure equals 370 Pa).

To design 9-storey cast-in-situ apartment building we have to use MONO-MAKH-SAPR.

First of all, we need to use BUILDING module and to design the first floor of the building (fig. 3.1) with all necessary structural elements (columns, slabs and walls). We use next materials: class of concrete C25/30, reinforcement A400C, wall partitions – brick.

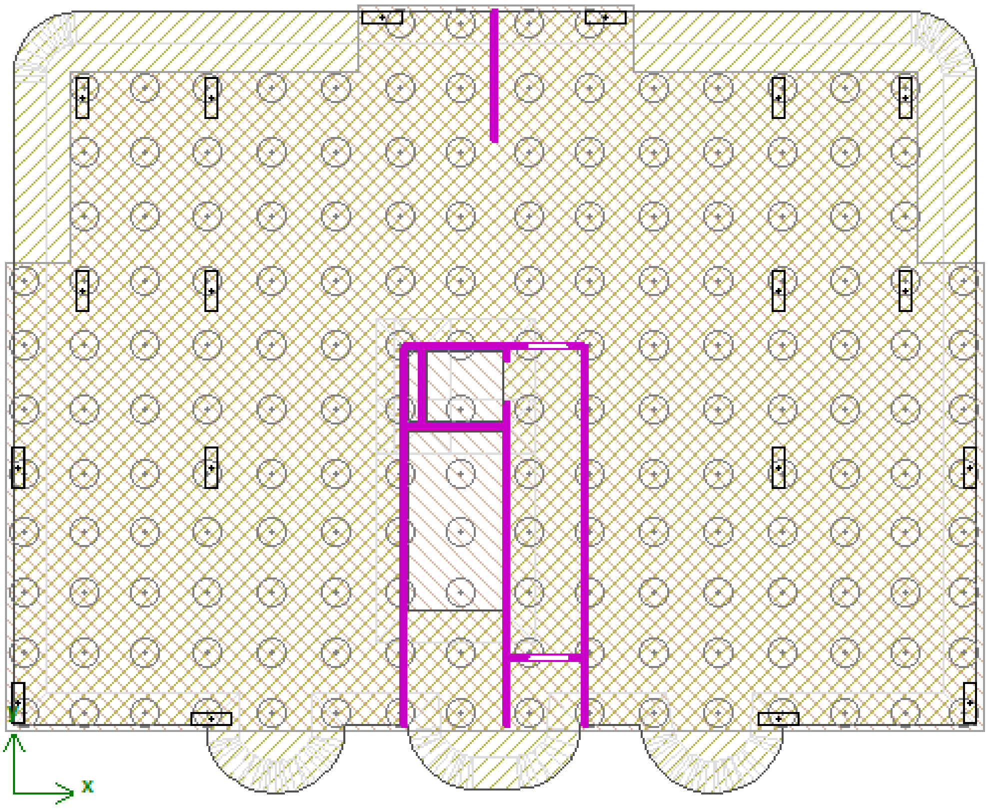

Fig. 3.1. Layout of the ground floor

We must create loads according to the calculations. When this step is done, we can copy necessary number of floors. The last step of design is creation of mat foundation (fig. 3.2).

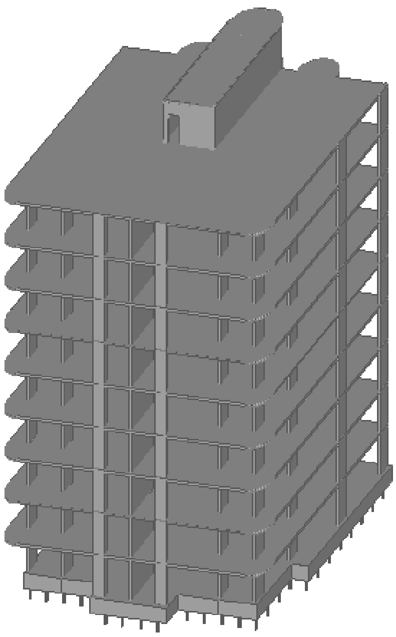

Fig. 3.2. 3D model of apartment building in MONOMAKH-SAPR

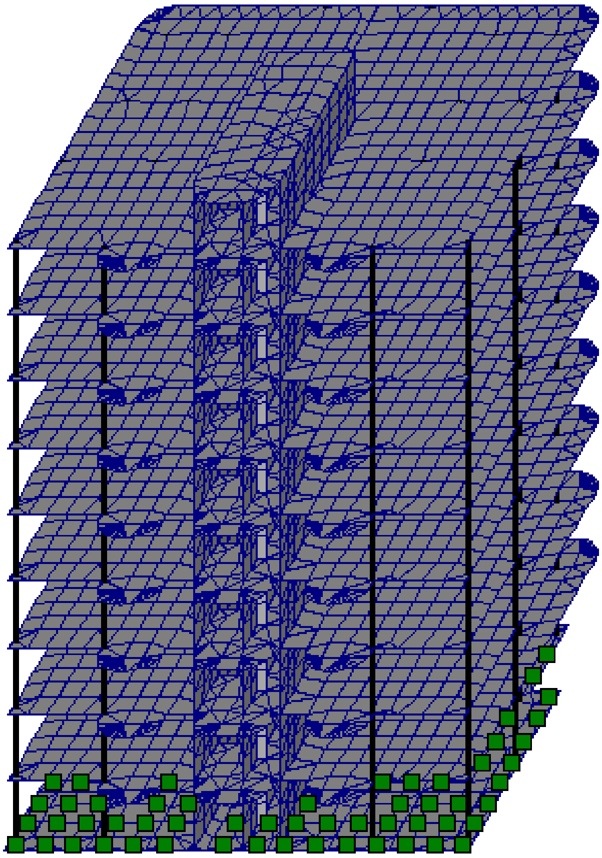

Fig. 3.3. FEM model of the apartment building in MONOMAKH-SAPR

To analyze the result of FEM analysis, lets consider the most stressed column and wall (fig. 3.4-3.7).

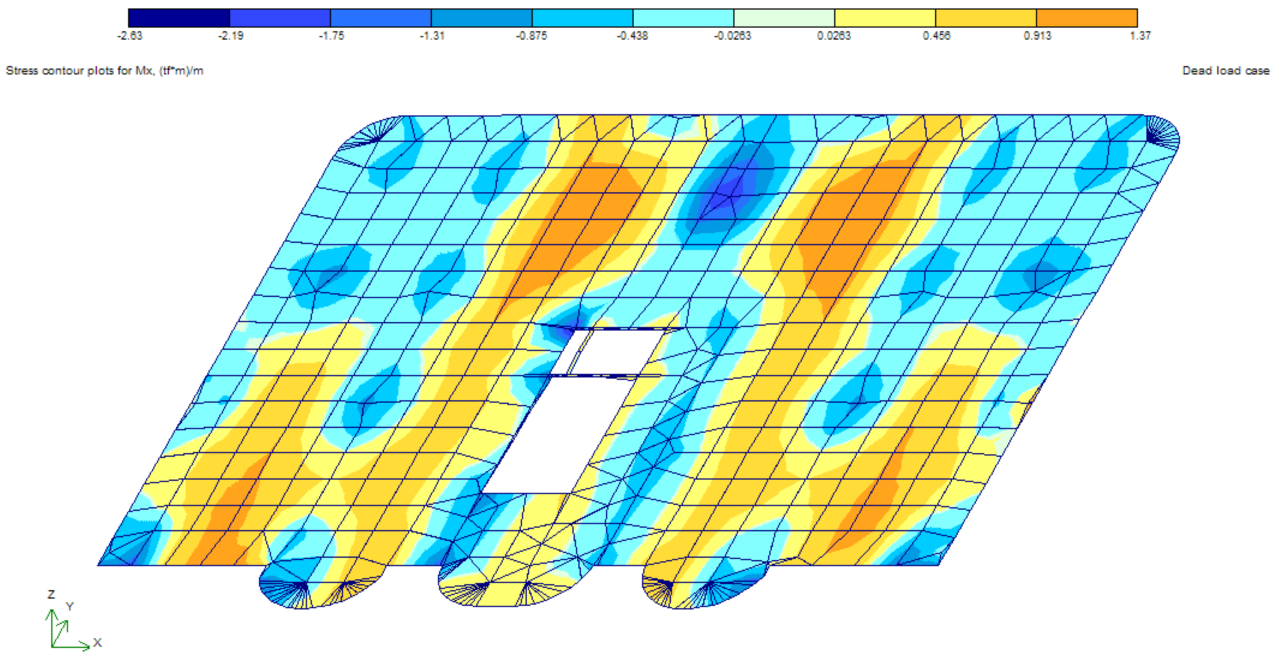

Fig. 3.4. Isofield of stresses and efforts M_x of the ground floor slab

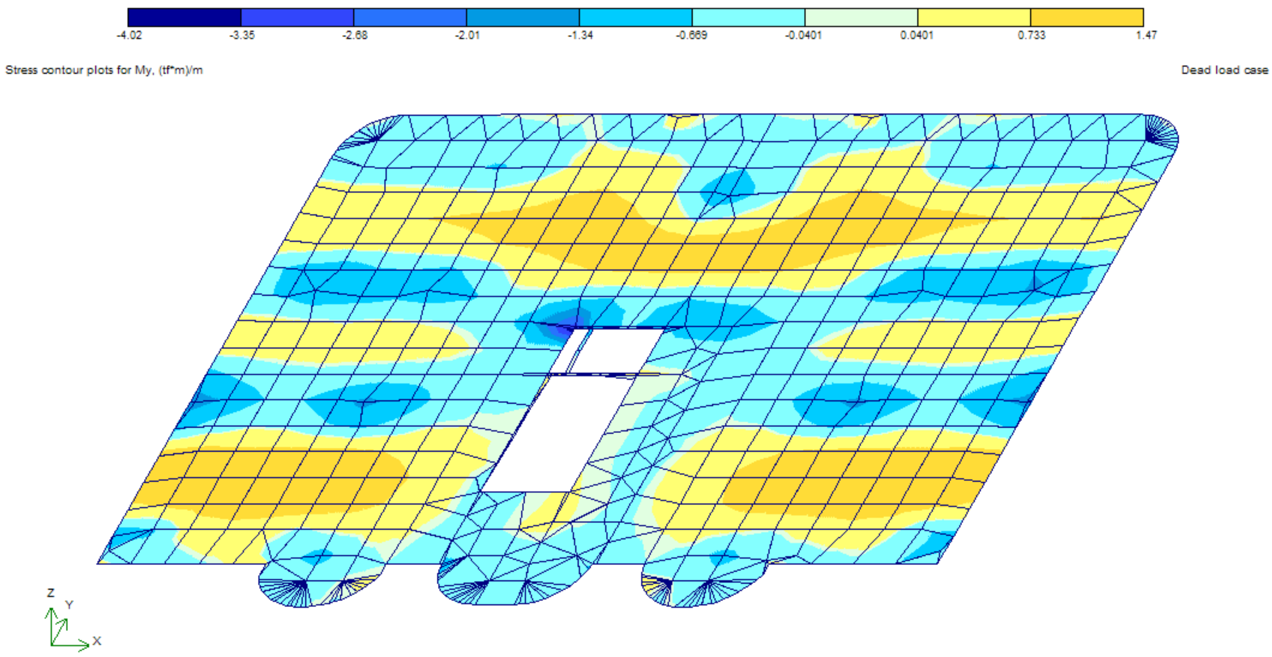

Fig. 3.5. Isofield of stresses and efforts M_y of the ground floor slab

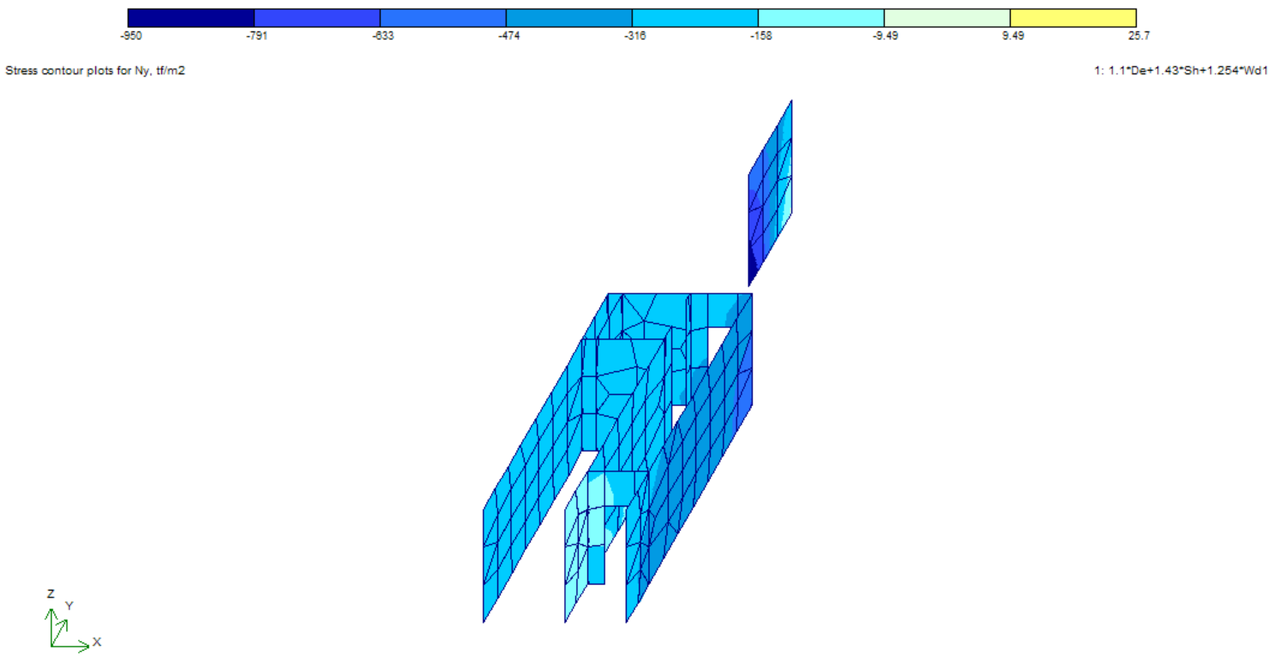

Fig. 3.6. The reinforced cocnrete wall with the largest value of the force N_y under the 1st type of load

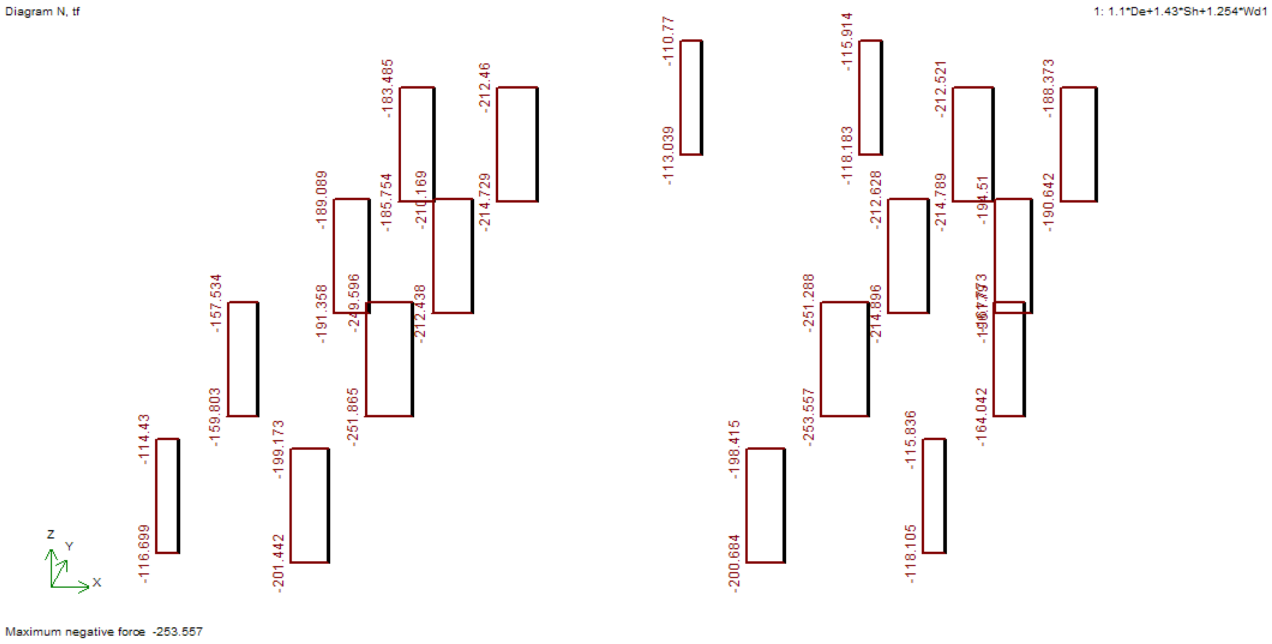

Fig. 3.7. The reinforced cocnrete columns with the largest value of the force N_y under the 1st type of load

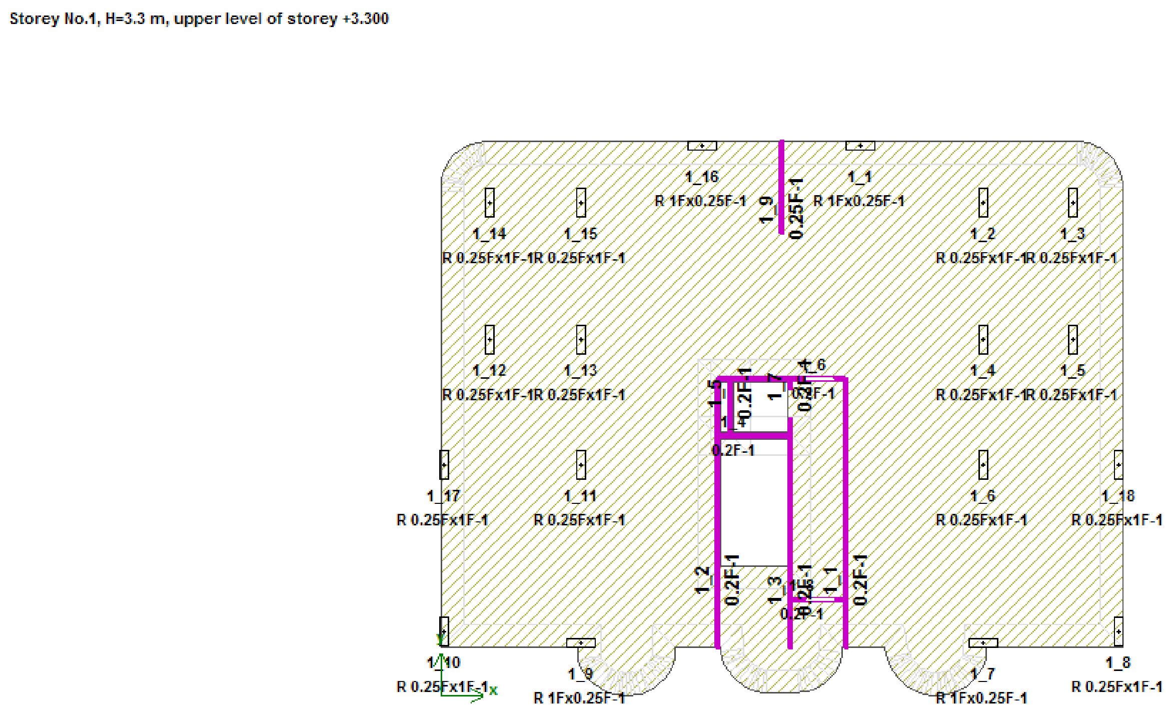

Fig. 3.8. Model view with numbers of reinforced columns and walls

Reinforced concrete wall with the largest internal force N_y is 1_9.

Column with the largest internal value efforts N_y is 1_6.

CHAPTER 4. CONSTRUCTION TECHNOLOGY

The monolithic construction technology is a type of construction technology that allows for the rapid construction of apartment buildings. It accelerates construction by utilizing specialized formwork such as tunnel formwork [20].

Monolithic construction is a type of construction in which columns, walls, mat foundation, piles and slabs are cast together. This means the concrete pouring in slabs and walls are done simultaneously [20].

Monolithic construction is often a much faster method of laying down apartment building foundations and is popular in developments where a large number of apartment buildings must be built quickly. There are a few other advantages to monolithic concrete construction, but there are also some disadvantages, leading some companies to prefer step-wise construction methods over monolithic [20].

Benefits of monolithic construction [20]:

- Allows for faster construction.
- It contributes to quickly closing the housing supply-demand gap. Give a faster solution to the housing shortage.
- This technology aids in project cost and time optimization.
- The structure was built with the best use of time, money, and building materials.
- It provides a disaster-proof structure.
- When compared to conventional buildings, monolithic structures are more resistant to horizontal forces (earthquake, cyclone, etc.).
- In the case of a building constructed with aluminum formwork, no expensive construction equipment is required.
- There is no need for any type of bricks, blocks, or plastering work in this technology.
- Monolithic structures are box-like structures that are more desirable from an earthquake standpoint.

- We get an Excellent Finished structure without incurring exorbitant plastering costs.
- Because the wall thickness is less, we have more plinth and carpet area.
- When compared to conventional construction, the durability and quality of monolithic construction are extremely high.
- The monolithic construction was quick and light.

Disadvantages of Monolithic Construction:

- Skilled and semi-skilled laborers are required.
- Workers needed a few days of training.
- Monolithic construction is difficult to repair and maintain.
- Thermal radiation is more prevalent.
- Expensive Initial Investment
- A special type of formwork, such as tunnel formwork, is required.

One of the most common alternatives to step-wise foundations is monolithic construction for foundation slabs. Monolithic slabs combine the concrete slab and the foundation footings into one item rather than breaking the foundation up into multiple pieces. You'll pour your slab and footing at the same time, allowing you to finish your projects faster [20].

Monolithic foundations are significantly thinner than more traditional foundations. The footings for these foundations are typically only 30 cm from the base to the floor, and the foundation is only four inches thick. While some specialized digging equipment can be used to speed up the job, you can usually handle the digging by hand because you only need to dig a few inches into the ground [20].

Monolithic slabs also rest on top of a gravel bed, which is designed for proper drainage. The slab will also include wire mesh or rebar to strengthen it and reduce the likelihood of cracking. In particularly cold climates, a layer of insulation that surrounds the foundation and provides internal heating can be added. The insulation layer will keep your structure safe from thawing and freezing by pushing the frost line away [20].

Construction of a monolithic reinforced concrete slab step by step [20]:

1. Ribbed in the form of an interconnected system of monolithic beams and slabs are crossed. The main beams are the slab elements (Purlins). Secondary beams surround them (ribs). A rectangular grid of columns is used in this type of flooring. Accept caisson slab with a square grid of columns.

2. The caisson slab is made up of rows of monolithic beams with the same cross-section. Beams with identical cross-sections that are monolithically connected to the floor slab. Caissons are a type of beam. Such slabs are used to improve the look of the ceiling and the interior of the room.

3. A solid monolithic slab of 150 mm - 200 mm thickness is used for reinforced concrete ceilings without beams. Solid monolithic slab with a thickness of 150 to 200 mm supported by columns. Expansion – capitals are used to increase the area of support in the upper part of the column.

Monolithic reinforced concrete slabs are commonly used in complex-configuration buildings to increase spatial stiffness under high loads. The spatial stiffness of the building is ensured by monolithic slabs, but they are labor intensive [20].

They are labor intensive, necessitate a large amount of wood, and lengthen the construction time. As a result, the following innovative and promising building systems are being used. As a result, new prefabricated building systems are being used [20].

This technology is frequently used in urban areas and on various types of concrete slabs. Concrete slabs are typically monolithic (ribbed, girder, or plate). Depending on the loads, span lengths, and other factors, concrete slabs are typically a variety of monolithic slabs (ribbed, girder, or girderless). Concrete slabs can be realized in several ways, including monolithic slabs, precast-monolithic (often ribbed) flooring, and precast reinforced concrete slabs [20].

Concrete flooring varieties have their own distinct characteristics, as do all other types of flooring. The strength, low thickness of the structure, durability, and ease of use are all characteristics of all types of floor slabs [20].

The classic monolithic floor slab for a residential building is a seamless, smooth slab without the device of voids for relief (as in the case of precast concrete slabs), with a thickness ranging from 5 to 20 cm depending on building regulations [20].

When it comes to the construction of a monolithic slab, there are two types: girder and girderless. A beam stiffens the slab, and the slab is positioned in the middle of it to reduce the bending moment [20].

The intermediate floors of residential buildings are typically girderless, but if the span is wide enough, a girder can be constructed as a safety bar. There are numerous methods for reinforcing a monolithic slab, and class A400C reinforcement is recommended (hot-rolled steel). The diameter of the reinforcement pins is determined by It ranges from 8 to 14 mm. The reinforcement is a two-layer cross-linking of reinforcing bars in a continuous mesh with a mesh size of 150x150 mm or 200x200 mm. The first layer is installed at the bottom of the future slab, a few centimeters away from the formwork.The first layer is placed at the bottom of the future slab, a few centimeters away from the formwork, and the second layer is placed on top of the formwork. The first layer is two centimeters away from the formwork, and the second layer is placed on top, covered with a couple of centimeters of concrete and having a thickness consistent with the overall design [20].

A layer of thermal / acoustic insulation can already be added to a modern monolithic floor slab with thermal insulation. Polystyrene foam and mineral wool insulation boards are pierced with They are pierced with metal brackets and affixed to the aligned boards [20].

After the reinforcement scaffolding is installed, the monolithic slab is poured. As a result, the floor slab is installed in less time and at a lower cost. As a result, you'll save time and money on additional insulation and adhesive materials [20].

The monolithic beamless slab is the second type. They are used in areas where smooth ceilings are required. They are, for example, widely used in subways and subways. They are inseparable flat slabs supported by columns. The latter have capitals as well. Prefabricated monolithic beam-free slabs are distinguished by their column grid, which is either square or rectangular. The supports are typically arranged in a 6x6 m pattern. Precast, span, and over-column panels are used to lay such slabs [20].

Advantages [20]:

Beamless slabs have a number of distinct advantages over conventional slabs. The benefits of such structures include, first and foremost;

Finishing work that requires little labor; reduced building height and cubic volume; improved sanitary conditions Smooth joist-free slabs are far easier to finish than standard slabs. You don't even need to prepare the ceiling in this case. All that is required to treat such a slab is to plaster it and then paint it. Both of these operations are relatively quick. A beamless reinforced concrete slab is typically thinner than a traditional slab. As a result, the building will be smaller for the same cubic capacity. A slab surface without beams is much easier to maintain. In this case, there are no gaps in the ceiling or floor construction where debris or dust can become trapped. As a result, pathogens of various types do not breed in such ceilings. This is why, for example, this type of construction is commonly used in food processing plants and hospitals [20].

The following are some drawbacks [20]:

- There are, of course, drawbacks to this type of slab. The primary disadvantage of this type of construction over girders is its weight. The supports for this type of slab must be as strong as possible.
- The limited span width of beam-less structures is another disadvantage. The distance between the slab supports should be kept to a minimum. Reinforced concrete is an extremely durable material. However, when subjected to a significant area and a heavy load, such a slab will begin to sag and may even collapse.

It is only economically viable in spans no wider than 5x6 metres with a load of 5 kN/m^2. The design of beam-less slabs is a difficult and time-consuming process. Such work can only be done by a highly qualified and experienced engineer. The difficulty in creating drawings is, of course, a disadvantage of such structures [20].

Installation of monolithic slabs [20]:

The main advantage of monolithic slabs is that heavy vehicles and lifting equipment are not required. It is built on-site, and all that is required is small-scale mechanization [20].

The reinforcement frame should be at least 3 cm away from the formwork wall. This is done to ensure that the concrete can fill this space and that the structure's strength meets the design specifications [20].

To lay a pipeline, special thermo wells with diameters greater than the outer cross-section of the communication pipes are inserted into the floor slab, and the gap between the thermo well and the pipe is sealed with tarred caulk [20].

The stages of building a cast-in-place slab are typically divided as follows: The formwork is being installed. This is the most important stage, because the operational characteristics of the future overlapping are dependent on the accuracy with which these elements are installed. Only professionals or people with extensive experience should be entrusted with such work [20].

The concrete mixture is being poured. This stage of the work should be completed quickly, and it is recommended that special construction vibrators be used to compact the concrete in order to achieve the required slab strength characteristics [20].

Structures of this type are cast in a pre-assembled wooden formwork. The formwork's bottom is also made of planks. Special telescopic supports support it from below. The casting is then completed as follows: the armature is installed on special mushroom stands, and the concrete mixture is poured into the formwork. Construction mortar is manufactured in factories under strict adherence to all appropriate technologies in terms of proportions and homogeneity. A hose from a tanker truck feeds it into the formwork. After about two weeks, the mold is removed. During this time, the slab is watered with a hose on a daily basis to prevent surface cracks. After a fortnight, construction on the building can resume. The concrete takes at least a month to reach sufficient strength [20].

CONCLUSIONS

The topic of the bachelor thesis is the apartment building in Gostomel, Kyiv region.

Natural conditions for construction of the apartment building were estimated. Load-bearing elements (reinforced cocnrete columns, walls, slabs) were designed by using finite element software MONOMKH-SAPR.

Finite element modelling (FEM) of the apartment building in Gostomel is performed. Reinforced concrete slab, column and wall are designed. Construction procedure of monolithic reinforced concrete slab is developed.

References

1. ДБН В.1.1-12:2006 Защита от опасных геологических процессов, вредных эксплуатацинных влияний, пожара. Строительство в сейсмических районах Украины. – [Дата введения с 2007-01-02]. – К. : Укрархбудінформ, 2006. – 55 с.
2. ДБН В.1.2-2:2006 Система забезпечення надійності та безпеки будівельних об'єктів. Навантаження і впливи. – [Чинний від 2007-01-01]. – К. : Укрархбудінформ, 2006. – 75 с.
3. ДСТУ Б В.2.6-156:2010 Конструкції будинків і споруд. Бетонні та залізобетонні конструкції з важкого бетону. – [Чинний від 2011-01-06]. – К. : Укрархбудінформ, 2011. – 118 с.
4. ДБН В.2.5-28-2006 Природне та штучне освітлення. – К.: Мінбуд України, 2006. – 80 с.
5. ДБН В.2.6-31:2006 Конструкції будівель та споруд. Теплова ізоляція будівель. – К. : Міністерство будівництва, архітектури та житлово-комунального господарства УКРАЇНИ. – 44 с.
6. ДБН В.2.1-10-2009 Основи і фундаменти споруд. Основні положення проектування. Київ, Мінрегіонбуд України, 2009.
7. ДСТУ-Н Б В.1.1-27:2010 Захист від небезпечних геологічних процесів, шкідливих експлуатаційних впливів, від пожежі. Будівельна кліматологія. – [Чинний від 2011-11-01]. – К. : Укрархбудінформ, 2011.
8. ДСТУ Б А.2.4-7:2009 Правила виконання архітектурно будівельних робочих креслень.
9. Корнієнко М. В. Основи і фундаменти: навч. посібник. – К. : КНУБА, 2003.
10. Гетун Г.В. Архітектура будівель та споруд. Основи проектування. Книга , 1. Видання 2-ге, перероблене та доповнене. — К. : Кондор, 2012. — 380 с.

11. Родченко О. В. Комп‟ютерні технології чисельного моделювання будівельних конструкцій : лабораторний практикум / О. В. Родченко. – К. : НАУ, 2012. – 36 с.
12. Родченко О. В. Комп‟ютерні технології чисельного моделювання будівельних конструкцій : методичні вказівки до виконання курсової роботи / О. В. Родченко. – К. : НАУ, 2014. – 52 с.
13. Родченко, О.В., & Ляшенко. Л., (2009). Investigation of the safety factor of a pile with increases seismicity areas. Advances in Aerospace Technology, 40(3), 166–170.
14. Belounar L., Guenfoud M., A new rectangular finite element based on the strain approach for plate bending, Thin - walled structures, 43, (2005), pages 47 – 63.
15. Engineering students' guide to multi-storey buildings: https://www.steelconstruction.info/Engineering_students%27_guide_to_multi-storey_buildings
16. Mary Cunningham, Sharon McDonald (2006) Promising Strategies to End Family Homelessness, June 2006: http://www.hoopsforthehomeless.org/docs/hoopspaperfinal.pdf
17. Multi-storey building: https://www.designingbuildings.co.uk/wiki/Multi-storey_building
18. Rodchenko O. V. Computer technologies for concrete airfield pavement design / O. V. Rodchenko // Aviation. – 2017. – Volume 21(3). – P. 111-117. https://doi.org/10.3846/16487788.2017.1379439
19. *Rodchenko O.V.* Engineering fundamentals of airports construction: lectures course / O.V. Rodchenko, V.Yu. Gyrych. – K. : NAU, 2012. – 108 p.
20. Sanjay Singh (2021), What is Monolithic Construction Technology: Advantages: https://www.civilengineeringweb.com/2021/03/what-is-monolithic-construction.html

APPENDEX A

DRAWINGS OF THE APARTMENT BUILDING IN GOSTOMEL