Housing construction design taking into account dust content index of climate in the Russian Federation

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Abstract. The article deals with the residential buildings’ design taking into account the dust content of dry climate. At the same time, such certain principles of designing buildings and structures in special conditions should be taken into account as: orientation to the cardinal points, wind direction, the amount of solar energy, the number and size of windows, wall thickness, roof slope, etc.

Introduction
The object of research is the design of residential buildings taking into account the dust content of the dry climate of the Russian Federation.

The subject of the research is the principle of designing residential buildings in a climatic zone of a dry climate. When designing buildings, it is important to pay attention to the climatic zone in which the building will be located. The main goal of this approach is to provide the residents with the most comfortable conditions throughout the year. Dry, hot climate has a number of special properties that should be considered when designing buildings. Cold, dry climate, in turn, has some troubles, depending, however, almost exclusively on the low temperature, against which a person can successfully fight and therefore can arrange his life tolerably and without harm to health.

1. Natural and climatic factors affecting housing construction
The quality level of individual residential buildings is determined by their functional, architectural, constructive, hygienic, aesthetic, economic and many other indicators. In this regard, the main goal of the design and construction of individual housing is to achieve only comfort. And in order for the house to be comfortable, during its construction it is required to fulfill a number of complex requirements and take into account a whole range of specific factors. Before getting to grips with the project, it is necessary to study what features the air, water, relief, vegetation in the area of the land plot have. The greatest influence on a private house design is exerted by atmospheric conditions. This is due to the fact that state of the atmosphere determines how much the ground on the site will warm up, whether there is enough moisture for the plants planted near the house, and finally, whether the wind that will rip off the roof or not. Of course, you can build a universal house suitable for any climatic region, but it is much easier and more economical to focus on local conditions and take them into account as much as possible in the design.

Building climatology is a section of industry codes that defines the requirements for the design of buildings and housing construction, taking into account climatic conditions. Climatic elements are: air temperature and humidity, wind, solar radiation, precipitation. Temperature, relative humidity and wind...
make it possible to compile the climatic characteristics of the territory, city. The critical values of the main climatic factors help to determine the climate characteristics and the critical values of various climatic factors are functionally related to each other. Knowing the criterion values of the elements, it is possible to identify the climate specifics, to establish the elements’ deviation degree from convenient conditions and to formulate a set of requirements to be taken into account when designing buildings, adjoining territory and development. The design is carried out in such a way as to compensate for sudden temperature fluctuations, to exclude the possibility of overheating in the south and hypothermia in the north.

**Wind mode**

The strength and direction of the wind significantly affect the dwelling, so the designers develop a special diagram - the "wind rose". This graph in the form of a multi-pointed star (rose) clearly shows the frequency of winds in summer, winter or any other period of the year in one direction or another. Figure 1 shows the "wind rose" for the city of Rostov-on-Don.

![Wind rose diagram](image)

**Picture 1.** "Rose of the Winds" of Rostov-on-Don.

On the windward side, where the wind pressure creates a zone of increased pressure, windows and vents can be smaller than the vents on the opposite side of the house. Taking into account the wind regime is very important when developing a master plan for a complex estate development of a residential building together with outbuildings, a garage, a land plot and neighboring buildings. The architect should choose the right objects’ layout, the configuration of buildings and the spacing between them. For example, in hot, humid climates, significant gaps should be left between buildings to increase air circulation.

In harsh climatic conditions with strong winds in the 1st climatic region and other regions, the opposite uncomfortable situation arises, which should also be taken into account when designing housing. So, in the Far North, the combination of strong winds with low temperatures leads to increased heat loss in the building and ventilation of enclosing structures. To prevent these phenomena, special architectural solutions are used to reduce the effect of cold wind on a residential building. In addition, in the 3rd and 4th climatic regions with hot and dry climates, strong winds often carry a significant amount of dust and dirt. To protect against this, special shielding properties of buildings, green spaces, closed courtyards, houses with gaps and voids to the entire depth of the body, and other measures can be used.
Figure 2. Features of building design in dry or humid climates

Snow and rain regimes
The entire territory of the Russian Federation is divided into three zones of humidity: wet, normal and dry zones. For example, St. Petersburg is in the wet zone, Moscow is in the normal zone, and Orenburg is in the dry zone. In general, snow and rain are the unfavorable factors for the housing operation, since they, like wind, carry harmful substances contained in the atmosphere. To protect against snow and rain, the following techniques are provided:
• waterproofing of structures and reliable drainage from the roof;
• external drainage from the house into ditches and other structures;
• special snow-protective building of the territory;
• installation of a drainage system and slopes of the territory;
• snow protection of external surfaces for the buildings with cladding and painting with special resistant compounds;
• intermediate cornices, pediments and ventilated air layers in the walls, as well as other urban planning and constructive solutions.

Characteristics of dust content in a dry climate and its influence on the building design
The high dust content of the urban environment is the cause of serious ecological and hygienic problems in cities. The negative impact of dust is manifested in various spheres of human activity, especially in urban construction and economy. Dust content leads to an increase in economic losses due to an increase in the cost of operating and repairing buildings and structures and a harmful effect on vegetation. Dust content of the urban environment, associated with an increase in the amount of man-made dust in residential buildings, significantly exceeds the volume of natural sources. The drier the air and soil and the higher the wind speed, the higher the dust content in the air. The sizes of dust particles range from the particles visible without any special gadgets to the particles that are barely visible under a microscope. The smaller the dust particles, the longer they do not settle. Reducing the dust content of the urban environment is effective with an integrated approach, in which urban planning and construction techniques are used. The measures carried out with the aim of improving the environment can prove the ecological reconstruction of residential buildings or its reorganization, where it is necessary to conduct a comprehensive assessment of the dust content of the environment and include three main stages:

The first stage of the ecological reconstruction pre-design analysis is to determine the background assessment of the dust content of the environment and the qualitative characteristics of the dusty air flow entering the residential group.

The aeration regime and the soil type of a given territory is determined for:
- local sources of dust formation and their zones of influence on the residential group;
- urban planning factors that increase the dust content of the urban environment.

Zones of potential dusting within the boundaries of an unfavorable wind sector are marked on the general plan of the area on a scale of 1: 10000, 1: 5000. The result of the first stage of the pre-project analysis is to determine the sequence of ecological reconstruction of the urban living environment.

The second stage of the pre-project analysis consists in building a map of dust-wind activity of the territory of a residential group, which is carried out on a scale of 1: 1000. The zones are determined according to the following:
- dust-wind shade zone;
- possible dust transfer zone;
- dust-wind activity zone;
- dust-wind hyperactivity zone.

The third stage of the ecological reconstruction pre-design study solves two problems:
- determines the sources of dust formation on the territory of the residential group;
- determines the dust resistance of building facade materials.

Determination of dust formation sources on the territory of a residential group is carried out on the basis of coatings’ differentiation according to the principle of dusty and non-dusty coatings, of artificial or natural origin. Combining the map of dust-wind activity of the residential group territory with the coverage scheme inside the courtyard territory makes it possible to assess the dust content of the sites and to zonate the territory according to the degree of dust content:
- dust deposit zone
- low dust content zone;
- medium dust content zone;
- high dust content zone.

Reducing the dust content of the environment by the construction methods is carried out by differentiating the surface of the building facade into the tiers that satisfy the level of the basement, first, second floors and above. According to the tiers of the building facade, it is recommended to use the facade building materials with certain properties of the surface texture. The result of the pre-design analysis is the development of comprehensive measures for the ecological reconstruction of the urban living environment in order to reduce its dust content. The ecological reconstruction of the city dwelling consists in carrying out the activities that have urban planning, construction directions and activities related to improving the microclimate in the territory.

**Summary**

When designing residential buildings, it is important to target the climate zone in which it will be located. After all, the goal of a successful design depends on many factors. For example, dry, hot climate has a range of special properties that should be considered when designing buildings. In a hot, dry climate, air temperature during the day in summer reaches 45 degrees Celsius, and the humidity does not exceed 20 percent. This type of climate is most noticeable in the areas located away from the sea coasts and in which there is rather low rainfall. Consequently, during construction, first of all, the impact of solar energy, its maximum use is taken into account:

1. **Location of the building.** The longer walls of the building should face the North and the South to minimize solar exposure. The kitchen should be located on the leeward side of the building. This will help avoid hot air circulation and odors from the kitchen.
2. **Windows and openings in the walls.** If it can be permitted in the project, windows and openings should be larger and more in the North and West of the building. It is preferable to build awnings and verandas, which in turn act as a barrier to radiation and reduce the level of hot air entering the house.
3. **Thickness and painting of walls.** This factor plays an important role in the thermal insulation of a building. In a dry, hot climatic zone, thick walls are most preferable, because they will serve as an insulating barrier against the excessive heat penetration. Painting the walls is also essential. Light
colored walls as well as reflective paints do not absorb heat, so they are a good option in hot climates. Walls with a smooth finish will help achieve the best effect. The presence of voids in the walls will also enhance the insulation effect.

4. Roof. Good insulating material, upwind slope are the main requirements for an insulated roof. A suspended ceiling can also be used to improve insulation from external heat.

5. Vegetation. It is necessary to include the planting of large shady trees near the walls in the project of the territory adjacent to the building. This will provide shade and cool air around the house.

For example, in a cold climate zone, compact volumes with asymmetric gable roofs are common. The steep slope of the roof is oriented to the South, longer, gently sloping - to the North, because in this case it is better able to withstand snow and wind loads. Basement and basement floors, attics are heavily insulated, the entrance to the house passes through the vestibule. City houses are blocked to reduce heat loss. In cold climates, compact, "assembled" volumes with a minimum of protruding parts and niches protruding into the total volume are appropriate. A gable roof is advisable, it can be asymmetric. The steep roof slope should be oriented to the South. If the slope faces North longer and gentler, then it resists snow and wind loads better. Basement and basement floors, attics should be heavily insulated, the entrance to the house should be done with a single or double vestibule. Urban and rural houses can be blocked to reduce heat loss. The north facade has minimal glazing. Colder areas are characterized by a compact layout of structures without kinks in the outer walls, insulated floors of the first floor, increased areas of entrance vestibules, and reduced window openings.

In addition to these factors, the terrain and surrounding buildings can have a significant impact on houses. The relief of the area with a slight slope of the site, as a rule, does not affect the architecture of the house and permits almost any layout. With an increase in the slope to 10-15%, it is necessary to make already special decisions on the first floor, and with slopes of more than 15%, it is advisable to move to special types of residential buildings - terraced and others. At the same time, additional preparation of the territory, special calculations for the rooms lighting, the selection of appropriate types of houses and the methods of their construction are needed. It is inappropriate to use slopes facing North for housing construction, because in this case the premises and the site itself will not be sufficiently illuminated by the Sun. The surrounding area can also influence the architecture of the house. Urban cottages in the historical area are characterized by such a layout of new buildings, which supports and repeats the existing architectural styles, geometry and proportions.

On the contrary, it may be preferable not to assimilate, but to harmonious contrast of the designed private housing, achieved by complicating the architecture of facades, plans and details. All over the territory of Russia in the settlements there are special protection zones, established by the state to preserve the architectural and historical heritage. They define the maximum permissible height of newly erected buildings. The number of storeys of the projected building can also be limited to preserve the visibility of landscape and architectural landmarks - rivers, hills, palaces, bridges and other objects.

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