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IDENTIFICATION OF BUILDING CLIMATIC GUIDELINES OF GEORGIA BASED ON THE REGIONAL CLIMATE CHANGE

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Summary: *Identification of building-climatic norms and rules may be estimated as the project of important social-economical and financial effects. The problem urgency is preconditioned by the fact that the renewal of legal guidelines base has been taken place in Georgia. By joined action of Georgian government, UNDP (United Nations Development Program), also national and international funds the revision and adjustment with existed legislation of current technical norms and rules is conducting. According existing legislation the above mentioned standards and norms that acted in former USSR have no legal power, and the Georgian analogs don't exist in many cases. Hence the vacuum has been formed and the preparation of science based acts is necessary - for the creation of new guidelines base and provision of its adaptation with national legislation.*
Thus in Georgia the elaboration of new building climatic norms and rules is necessary because in real situation practically the building-climatic norms established according building norms and rules elaborated in Soviet period have been used, that is the reason of unbiased decisions and is connected with significant negative economic effect.

Key Words: *Climate change, climatic norms, climatic-building parameters*, *mathematical modeling.*

The building-climatic norms established according building norms and rules elaborated in Soviet period are defined on the base of those monitoring materials that reflect the climatic observation data of explored region including 1966 year. In this guidelines document (practically in acting climatic building norms and rules) Georgia is placed in forth climatic zone together with Armenia and Azerbaijan. It is unacceptable because the climate of South Caucasus and especially of Georgia for its geographic location, large hypsometric factors and other climate generating factors is characterized by important peculiarities. Reasoning from above said the assumption of the territory homogeneity of South Caucasus and particularly Georgian territory is wholly unjustified from the point of view of identification of building norms. Correspondingly it is necessary to detailed consider climatic conditions of separate regions in national building norms. This gives possibility to protect building objects from the negative impact of local climatic conditions what in future will make great economical profit (this differ from the current situation when all planned and started construction is realized without any consideration of risks connected with local climatic factors).

For the purpose of perfection of building-climatic zoning of Georgia at first it is needed to specify values of existing climatic parameters, based on the use of regular climatic monitoring data starting from 1966 year period, especially because of the global and regional climatic variations of last decades. The existing norms because of the limited period of its information base can't imply the modern climate change dynamics, what is the essential for the right planning and constructive decisions for building.

Implying climatic parameters is especially important for current situation when the shifting on the light construction has been taken place that is more sensible against change of climatic conditions. The sharp changes of air humidity and temperature influence of heavy showers and winds damages building objects that caused the decreasing of its exploitation level. For the correct projecting the different combinations of climatic parameters and their calculated values have to be considered – according different values from identified climatic norms.

The urgency and novelty of problem is preconditioned by the fact that by the project results complex approach of scientific research will be achieved, identification of building –climatic guidelines implying climatic variations, where the important role is given to the following:

- Specification of significances of existed climatic parameters (because climatic norms are defined up to 1966 year and don't consider climate change dynamics connected with the increasing of intensity of modern anthropogenic impact on environment);
-Complex influence of two and multidimensional climatic factors on building objects;
- New building-climatic zoning of Georgia (implying regional peculiarities of the state territory);
- Elaboration of safety norms against climate negative impact on the building objects and existing constructions.

The main goal of the project is the identification of building-climatic guidelines for separate regions of Georgia using methodical base determined according international standards and based on the corresponding calculations considering regular observation data of local climatic monitoring for the last periods.

In building climatology that is one of the branches of applied climatology, the great significance has the identification of special climatic parameters that are directly used while projecting some objects. Hence the science based identification method of one and multidimensional climatic complexes and its further development are essential.

The increasing rate of civil constructions building using new building materials caused the specification of climatic parameters considered by building guidelines requirements and the necessity to process corresponding special materials that determines the rapid development of building climatology.

To study climate impact on some object the negative as well as positive climatic factors have to be identified. In last years the experimental and theoretical investigations have been widely used to identify corresponding climatic factors. It has to be mentioned that the characters of many climatic factors used in building are identified according values determined from general climatic investigations. Particularly it mainly are the mean and extreme values of some climatic elements.

Using of existed climatic characters simplifies and accelerates their implementation in practice, but the consideration of climate by mean values of separate climatic parameters can't be taken reliable, because means are observed seldom and the provision of significance more than mean value is 50%. The use of extreme data isn't robust while solving practical issues.

For the identification of special climatic parameters it is necessary to ascertain:

- Peculiarities of climatic observations;
- Assessment of current meteorological and general climatic information from application point of view;
- Data processing methods;
- Relation between climatic elements.

The identification of those factors is necessary, to account atmospheric processes for given concrete issues.

The special climatic parameters determined in the presented project, that will be entered in building norms and rules.

Among them:

1. Solar radiation quantity on surfaces of different orientation and sloping including data of last ten year period
2. To realize thermal-technique report it is necessary to determine so called calculated temperature (internal air temperature for the most cold period of year). While determined this factor the following situation is important – rather than the wall is less massive, the short period averaging is needed to identify calculated temperature value. It is preconditioned by the fact that less massive wall rapidly reacts on the change of internal air temperature and became cold in short period. According calculated temperature value identified by location climatic parameter it is possible to determine required thermal resistivity and its thickness.

3. While studying thermal regime of building it is necessary to determine – is there any need in artificial regulation of microclimate inside the building. Thermal effect of internal air negative temperature in building is originated mainly from thermal-technical features and equipments (heating, ventilation) of supporting construction.

4. With the aim of regulation of building heating system it is necessary to calculate degree-day number and their distribution by months. Table data represent comfort (basic) temperature, that would be maintained between building and internal air temperature. This character is especially important while heating period

For degree-days calculation the following equation is applied

$$\overline{Q} = (T_i - \overline{T})n.$$

where: $\overline{Q}$-is mean degree-days number of heating period,T- air temperature in building is equal 18^0C, $\overline{T}$ - monthly mean multiyear temperature, n-number of days per year

5. Wind influence on buildings is revealed as the loading and presents the main source of building vibration. Excluding wind influence while constructing causes destruction of bridges, high buildings, breaking of wires. Main reason of accidents is incorrect assessment of wind loading, its character an distribution, neglecting of aerodynamical characters, construction vibration. While projecting high building the most important is the including of wind loading. For determination of building durability and dimensional instability it is desirable to obtain detailed information on wind in guidelines.

For the assessment of wind influence on buildings its calculating velocity and strength, profile by height, wind probability of different velocities and direction are determined.

In surface air layers wind direction and velocity is sharply changed due to different factors. It can act during relatively short time as shocks and also change directions. Air flows experience pulsation due to shocks and it is known as wind strength. It is explained using disorder motion or turbulence. In the case of small velocities may happen homogeneity or laminar flows.

On the base of observations in different climatic regions is determined the irregular character of wind strength, that excludes building possible resonance.

Wind loading on buildings is determined by the following equation:

$$Q = n\Sigma C_X \beta q$$

where: n- is overloading factor which is obtained according building height, q-wind velocity loading, β-dynamical factor that includes building reaction against wind strength.

While determine of wind loading great significance has the specification of wind velocity, because it is in second degree and thus the deviation may be too big.

Wind of high speed is rare event, but they produce too great wind loadings, the consideration of those ones is required.

Wind velocity load is determined by equation

$$q = \frac{v^2}{16} \text{kg/m}^2$$

6. It has to be emphasize the great significance of practical use of two and multidimensional climate complex. The matching is important of such elements as are the following:

- Temperature – water vapor partial pressure
- Temperature- relative humidity
- Temperature-cloudiness
- Temperature-wind velocity
- Wind-rain (especially indirect rain)

Wind and air temperature are important determent factors of building thermal regime. The whole thermo transfer will be greatest when low temperature contemporizes with very strong winds, thus to determine wind velocity and temperature (effective temperature) complex is required.

The effective temperature is the temperature when building thermal passing will be same as in case of internal temperature (T) and wind velocity (V)

The equation for calculating effective temperature has the following expression:

$$T_{ef} = T - CV^2(T_{in} - T)$$

where: T – internal temperature (while ordinary calculations it is equal to18 °C), C- factor characterizing infiltration characters of support constructions (ordinarily C=0.005), T –external air temperature, V-wind velocity m/sec.

7. The coincidence of greatest values of air temperature and humidity, sharp changes of temperature, heavy showers and influence of strong winds damages constructing. High humidity reduces service ability of constructions, negatively influences into the internal microclimate and may caused its destruction. To create normal humidity level all sources of moisturize have to be considered. Exploring humidity regime is impossible except study of thermal regime. Air temperature and humidity are main factors characterizing climate and influence on the humidity regime of supporting construction. To investigate temperature-humidity complex as ranged as well as hour observations will be used. The selection of temperature initial data is conducted after each 5 degree, and of relative humidity after every 5%.

To choose humidity zones, humidity complex parameter k is presented by project implementers

$$K = \frac{H\varphi}{Q_s\sqrt{A_t}}$$

where: H- is precipitation amount in warm period on vertical surface, mm,ϕ-relative humidity of he most warm month at 13h,%, Q_s- yearly mean radiation on horizontal surface, kj/m, Ai-annual amplitude of air mean temperature (January and July). %.

8. The identification of precipitation amount on the surfaces of different orientation and slopes is the important research issue of project. In observation net, precipitation measuring methods are equally distributed, as in plain also in mountain places. At plains precipitation measure shows real amount of precipitations, in mountain regions it is mentioned the inconsistency between slope moisturize and measured precipitations.

Precipitation amount on surface of different orientation and slope is mainly depended on wind velocity and direction. To determine precipitation amount for surface of any orientation and sloping the following equation is used:

$$H_{Hn} = H_g \frac{\cos\alpha\sin\beta + \sin\alpha\cos\beta(\theta - \theta_0)}{\cos\alpha}$$

where: H_{Hn} – rain amount on ramp mm, H_g -rain amount on horizontal surface, mm, α- rain incident, β-surface incident, θ-rain orientation (is obtained according wind orientation), θ_0- ramp orientation.

Precipitation amount on vertical surface is determined by the equation:

$$H_\Delta = H_j K \frac{V_w}{V_0}\cos(\theta - \theta_0)$$

where:H_Δ-is the precipitation amount on vertical surface (mm),H_j-precipitation amount on horizontal surface(mm), K-factor, considers distance from Earth, $V_0=4.5.I^{0.107}$ -rain drop velocity, with depending on intensity.

The characters of precipitations on the vertical surface will be the basis for elaboration of building protection measures against atmosphere impact, to protect building from moisturizing

9. On the service level of buildings the influence of precipitation mineralization is too great. The important role in atmosphere washing out from aerosol admixtures has precipitations. The assessment of amount of mineral matters washing down has significant interest, for this matter the realization of special researches has been determined considering peculiarities of different climatic conditions.

Expected results of the project are:

1.Identification of distribution peculiarities in space-time of special parameters:

- calculating temperature;
- degree days;
- wind strength;
- wind velocity loading

1. mathematical modeling of radiation on surface of any orientation and slope;
2. Investigations of distribution peculiarities of two and multidimensional complex climatic-building parameters (temperature-wind, temperature-humidity, indirect rain);
3. new building-climatic zoning and elaboration of relevant recommendations for the building protection from climate negative impact based on the revealed regularities of complex climate parameters;
4. Elaboration of safety recommendations of urbanization conditions, building infrastructure development strategy and investment medium for separate regions of Georgia

Scientific and commercial significances are:

From scientific and commercial point of view the project is most important because the identification of perfect climatic building norms may be estimated as important scientific, social-economical and financial project, that will be revealed in strengthening of scientific potential Georgian urban developing, particularly – the possibility to use specificated building-climatic norms at any step of projecting. It is most important that this specification will be realized considering modern climate change tendencies. For Georgia as for independent state it will be firstly constructed science based building-climatic guidelines considering climate change.

The project significance is determined by the following:

- Specified building-climatic norms based on climatic monitoring observation data over Georgian territory;
- Based on the specified building-climatic norms perfection of building-climatic zoning and elaboration of relevant recommendations;
- Elaboration of building mitigation and protecting recommendations against precipitation influence;

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