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CONSTRUCTION ZONING OF GEORGIA IN VIEW OF COMPLEX CLIMATIC CHARACTERISTICS

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Research method is based on the results of modern scientific researches in building climatology, consequently it may be deduced that research method wholly comply with Project goals and objectives.

To achieve Project objectives modern methods of applied climatology would be used, by using these methods distribution peculiarities of building-climatic parameters in space-time will be identified. The representation of temporal oscillations of climatic parameters through linear approximation (trends) will be realized, also analysis of revealed regularities by different periodical meaning.

For the calculation of building-climatic norms the use of daily climatic long-term continuous data of separate regions of Georgia is recommended, including last decade. It is preconditioned by that the increasing of frequency and intensity repeatability of anomalies of climatic parameters became more urgent due to the revealing of variations of global climate in last years. While calculating of building-climatic norms each station from climatic monitoring net would be checked on homogeneity, to reveal all those artificial shifts (or breaks) in data set, that is caused by the changing of coordinates of observation station, also measurement equipment or method. It has to be realized because often changes caused by the mentioned effects are comparable by their lines with required changes of climate and disfigure significances of long-term trends and dynamical characters.

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./1/.

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 will be 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 emphasizing 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

Tin – 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:

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

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

2. Mathematical modeling of radiation on surface of any orientation and slope;
3. Investigations of distribution peculiarities of two and multidimensional complex climatic-building parameters (temperature-wind, temperature-humidity, indirect rain);
4. Investigation of chemical composition of precipitations on vertical surfaces – to determine building corrosion;
5. 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;
6. 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;
- Expected commercial effect for whole country considering Georgian sustainable development, is annually defined within 100 thousand US dollars limits.

Georgia is one of the thunderstorm dangerous regions of the Northern Hemisphere /2/ soat constructing of building sand structures, Both in cities and in rural areas the need to provide them with lightning protection means exists.

In the absence of instrumental measurements, thunderstorm activity is estimated via climatic parameters such as the number of days with thunderstorms, duration of thunderstorms and more generic parameter - the number of lightning strokes per unit area of land. In the specific geographic region between these parameters can be traced correlation connection[3-5].This connection allows calculating the value of the number of lightning strikes to the ground– "N_g".

$$N_g = 0{,}04T^{-1.25} \qquad (1)$$

Where "T" is the number of thunderstorm days per year in the study area.

These values are used to determine the specific lightning influence on the structures of various configurations, particular, closely spaced building swithchimneys, antennas, towers, etc. The expected number of lightning strikes is calculated by the formula:

$$P = 9\pi H^2 N_g * 10^{-6} \qquad (2)$$

For rectangular buildings-

$$P = (W + 6H)*(L + 6H)N_g*10^{-6} \qquad (3)$$

Where W - width, L - length, H - height of the building. N_g - the number of lightning strokes per 1 km^2.

It should be noticed that when determining of lightning protection means, more important is the maximum value of days with lightning then average. The following table shows the average and maximum values of "N_g" for some cities and resorts of Georgia. In the calculation we used data from meteorological stations in nearly 70-year period.

Table 1. Average ($\overline{T}$, $\overline{N}_g$) and maximum (T_{max}, $N_{g\,max}$) annual value of the number of days with thunderstorms and number of lightning strikes per 1 km^2 in selected cities and resorts in Georgia.

	№	Station Title	$\overline{T}$	T_{max}	$\overline{N}_g$	$N_{g\,max}$

West Georgia	1.	Batumi	41	69	4	8
	2.	Chakvi	51	80	6	10
	3.	Kutaisi	37	69	4	8
	4.	Zugdidi	41	60	4	7
	5.	Jvari	32	65	3	8
	6.	Bakhmaro	28	50	3	5
	7.	Tsageri	39	82	4	10
	8.	Sairme	25	46	2	5
	9.	Ambrolauri	41	93	4	12
Eastern Georgia	10.	Tbilisi	36	58	4	6
	11.	Gudauri	49	73	5	9
	12.	Bolnisi	49	69	5	8
	13.	Gori	35	53	3	6
	14.	Dusheti	44	77	5	9
	15.	Telavi	48	70	5	8
	16.	Borjomi	35	61	3	7
	17.	Manglisi	56	76	6	9
	18.	Abastumani	51	76	6	9
	19.	Akhalkalaki	54	86	6	11
	20.	Akhaltsikhe	55	81	6	10
	21.	Faravani	55	84	6	10

As it can be seen from the table in western Georgia the affection varies from 4 to 8 lightning strikes on 1 km^2 and in areas of eastern Georgia - from 5 to 9 lightning strikes. These data point to a rather large lightning affection of study area.

It should be noticed that in order to improve the quality of calculations of lightning protection necessary to have a more differentiated assessment of lightning parameters, taking into account regional, climatic and physical characteristics. To solve these tasks it is necessary also instrumental data.

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საქართველოს სამშენებლო დარაიონება კომპლექსური კლიმატური მახასიათებლების მიხედვით./ლ. ქართველიშვილი, ი. მკურნალიძე, ლ. მეგრელიძე, ნ. შავიშვილი/საქართველოს ტექნიკური უნივერსიტეტის ჰიდრომეტეოროლოგიის ინსტიტუტის შრომათა კრებული-2013.-ტ.119.-გვ.91-96-ინგლ., რეზ. ქართ., ინგლ., რუს.
კლიმატის გლობალური ცვლილების ფონზე აუცილებელი გახდა ახალი სამშენებლო კლიმატური ნორმების გაანგარიშება. ახალი ნორმების დადგენა აუცილებელია იმიტომ, რომ ყოველ 10 წელიწადში ერთხელ მიმდინარეობს საერთაშორისო სტანდარტული კლიმატური ნორმების განახლება. ამასთან დაკავშირებით მმო-ს კლიმატის XII კონფერენციაზე მიღებულ იქნა გადაწყვეტილება იმის შესახებ, რომ სამშენებლო კლიმატური ნორმები უნდა განისაზღვროს ცალკეული რეგიონების მიხედვით. გარდა ამისა აუცილებელია განისაზღვროს სპეციალიზირებული კლიმატური მახასიათებლები, რომლებიც უნდა გათვალისწინებული იქნეს შენობების თბოტექნიკური მახასიათებლების განსაზღვრისას.
ნაშრომში დადგენილია კლიმატის სხვადასხვა კომპლექსური (ტემპერატურა – სინოტივე, ტემპერატურე – ქარი, ქარი - წვიმა) მახასიათებლების განაწილების თავისებურებანი საქართველოს ტერიტორიაზე. გარდა ამისა ნაშრომში გაანგარიშებულია ელვის მოხვედრის ალბათობა შენობებში, რომლებსაც არ გააჩნია მეხდამცავი მოწყობილობები. კვლევის შედეგები წარმოდგენილია შესაბამის ცხრილებში.

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CONSTRUCTION ZONING OF GEORGIA IN VIEW OF COMPLEX CLIMATIC CHARACTERISTICS./L. Kartvelishvili, I. Mkurnalidze, L. Megrelidze, N. Shavishvili/Transactions of the Institute of Hydrometeorology, Georgian Technical University. -2013. -V.119. -pp.91-96- Eng.; Summ. Georg., Eng., Russ.
Due to the global climate change there was necessary an establishment of new construction norms. It became necessary because each 10 years there is an updating of the international standard climatic norms. In this regard, the resolution was submitted for the 12th VMO conference that construction climatic norms have to be defined for certain regions. Besides definition of specialized climatic characteristics to consider them is necessary at establishment of thermo-technical characteristics of structures.
In an article for Georgia established features of the distribution of some complex (temperature-humidity, temperature-wind, wind-rain) climatic characteristics. In addition, for some regions of Georgia probabilities of hit of a lightning to the buildings deprived of lightning protection are calculated. The received results are presented in the corresponding tables.

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СТРОИТЕЛЬНОЕ РАЙОНИРОВАНИЕ ТЕРРИТОРИИ ГРУЗИИ С УЧЁТОМ КОМПЛЕКСНЫХ КЛИМАТИЧЕСКИХ ХАРАКТЕРИСТИК./Л. Картвелишвили, И. Мкурналидзе, Л. Мегрелидзе, Н. Шавишвили/Сб. Трудов Института Гидрометеорологии Грузинского Технического Университета. -2013.-т.119.-с.91-96. - Анг., Рез. Груз., Анг., Рус.
В связи с глобальным изменением климата стало необходимым установление новых строительных норм. Это стало обязательным потому, что каждые 10 лет происходит обновление международных стандартных климатических норм. В связи с этим на XII конференции ВМО было вынесено постановление о том, что строительные климатические нормы должны быть определены для отдельных регионов. Кроме этого необходимо определение специализированных климатических характеристик для того, чтобы учитывать их при установлении теплотехнических характеристик строений.
В статье для территории Грузии установлены особенности распределения некоторых комплексных (температура-влажность, температура-ветер, ветер-дождь) климатических характеристик. Помимо этого, для некоторых районов Грузии рассчитаны вероятности попадания молнии в здания, лишённые молниезащиты. Полученные результаты представлены в соответствующих таблицах.