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FEATURES OF TOWER STRUCTURE OBSERVATIONS

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Abstract: This article analyzes the influence of external factors on the geometry of tower-type structures under construction and in operation. Based on this analysis, the need to develop a methodology for geodetic surveys that takes these influences into account is proposed.

Keywords: tower-type structures, one-sided heating, structure curvature, curvature value, temperature fields, wind load, wind flow, solar heating, tower axis deviation.

ОСОБЕННОСТИ НАБЛЮДЕНИЙ БАШЕННЫХ СООРУЖЕНИЙ

Аннотация: в статье анализируются вопросы влияния внешних факторов на геометрию возводимых и эксплуатируемых сооружений башенного типа. На основе анализа предложены необходимость разработка методики производства геодезических работ, учитывающей эти воздействие.

Ключевые слова: сооружения башенного типа, односторонний нагрев, изгиб сооружений, значение изгиба, температурных полей, ветровая нагрузка, ветровой поток, солнечный нагрев, отклонение оси башни.

INTRODUCTION

Tower-like structures are complex engineering structures that are built and operated in harsh conditions. Their structural features are determined by their functional tasks and the nature of the forces acting on the structure during operation.

Tower-like structures, which consist of a small base area, are significantly exposed to external environmental influences, such as unilateral solar heating and lateral wind pressure, and as a result, their deviation from the vertical position can reach a certain magnitude [1-3].

RESEARCH METHODOLOGY

The unilateral heating of the building as a result of the action of direct and diffuse radiation of sunlight leads to the rotation of reinforced concrete structures in the direction opposite to the Sun. The absolute value of the rotation depends on the intensity of solar radiation, the thickness of the building wall, the humidity and pollution of the air at the current time, and other factors.

In sections of the tower consisting of different diameters, depending on the height, its lower parts heat up less than the upper parts, and as a result, the rotation process occurs later [4.5]. The same situation is repeated during the cooling of the structure, and as a result, the general appearance of the curved rotation throughout the entire structure takes on a spatial form.

The theoretical value of the displacement T_i of a point of the tower at a height N_i due to solar heating can be calculated using the following formula [5].

$$T_i = \frac{\alpha_i \Delta t H_i^2}{2 D_{\text{ср}}} \quad (1)$$

Here α_i is the linear expansion coefficient of the material used in the tower; Δt is the temperature difference on the sunny and shady sides, $D_{\text{ср}}$ is the average diameter of the tower.

It should be noted that when determining the value of the deflection under the influence of the temperature of the tower according to formula (1), the differentiated nature of the temperature fields, the peculiarities of the shape of the towers, and a number of other factors are not taken into account. Therefore, it is recommended to calculate the deflection value using the following

formula, taking into account the dependence of the point at the height of the tower on its height relative to the diameter and the values of the temperature difference.

$$T_i = \alpha_t \int \Delta t_i \frac{H_i}{D_i} dH \quad (2)$$

In the formula (1), the value of the average diameter can be written in the following form.

$$D_{middle} = D_{bot} - \frac{(D_{bot} - D_{top})}{2H} H_i \quad (3)$$

Here, D_p and D_{yu} are the lower and upper diameter values; H is the design height of the tower.

ANALYSIS AND RESULTS

To calculate the torsional value of the Tashkent TV tower with a height of 375 m, if we assume its lower diameter $D_{bot} = 35$ m, upper diameter $D_{top} = 15$ m, and $\alpha_t = 0.12 \cdot 10^{-4}$, then taking into account formula (3), we can write formula (1) as follows

$$T_i = \frac{\Delta t H_i^2}{(a - b H_i)} 10^{-6}, M \quad (4)$$

Here a and b are coefficients characterizing the geometry of the structure, calculated based on known tower parameters, in this case they are 6.67 and 0.0042, respectively.

According to the conducted studies, the temperature difference between the opposite towers along the diameter of reinforced concrete and metal towers is 15-20° C, and the average temperature difference along the tower shaft does not exceed 8-10° C [4]. Taking this into account, using formula (4), a graph of the deviation of the telegraph tower axis under the influence of solar heating was constructed (Fig. 1).

Based on this, it is recommended to determine the optimal time for conducting geodetic monitoring work from 500 to 1000 in the morning.

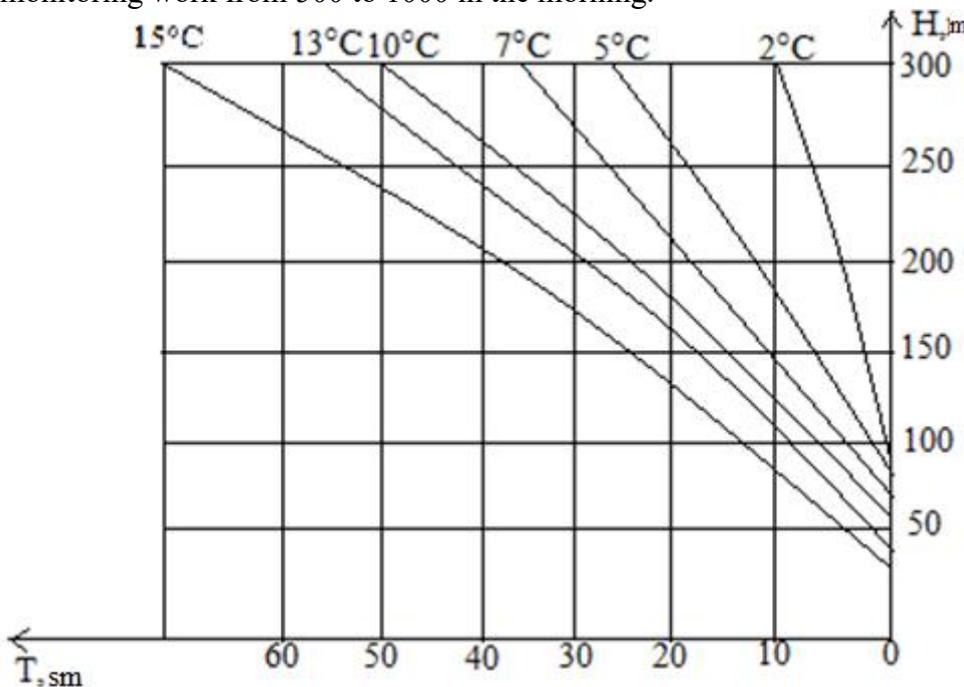


Figure 1. A graph of the TV tower twisting under the influence of solar heating

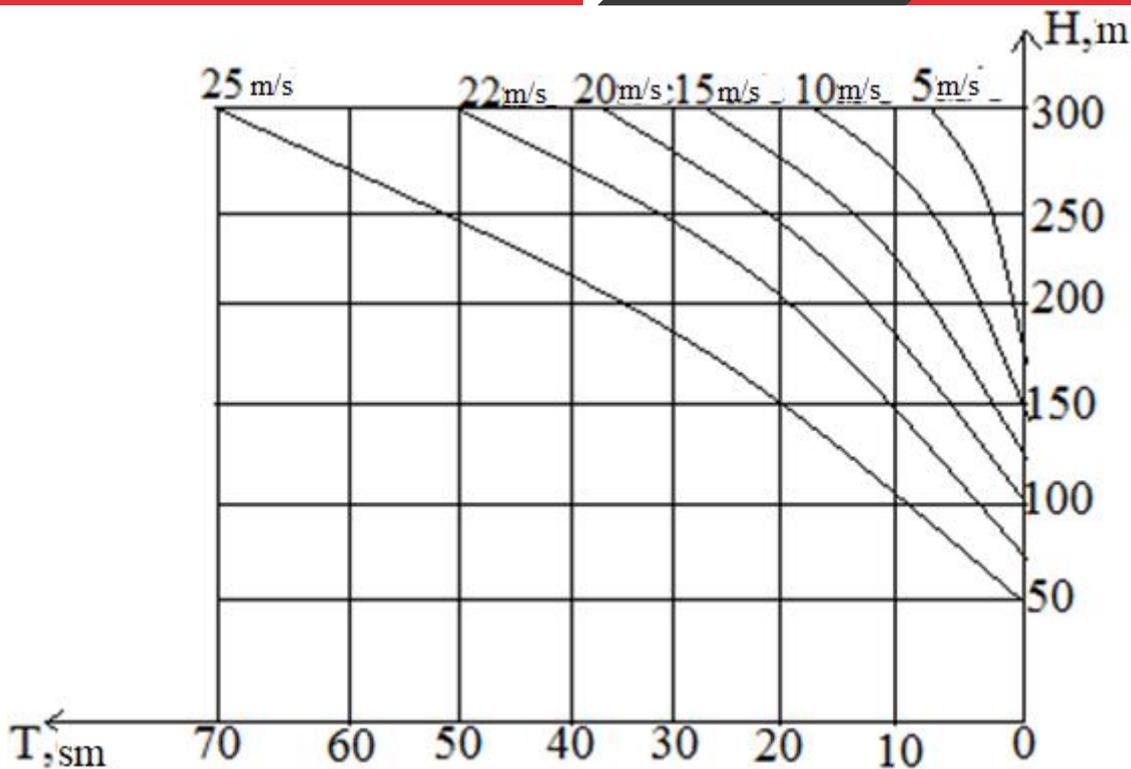


Figure 2. The graph of the deviation of the axis of the TV tower under the influence of wind pressure

The effect of wind pressure on the state of the tower axis is more complicated than solar heating and is characterized by the presence of static and dynamic displacements. The value of static displacement is not constant. Based on the results of the conducted experiments, a graph of the deflection of the tower axis under the influence of wind was constructed (Fig. 2).

Based on the results of monitoring the deflection of the tower under wind pressure and the constructed graph, we can see that the deflection of the structure axis is several times greater than the permissible value for the deflection of the television tower at high wind speeds.

Although the regulatory documents establish restrictions on the implementation of geodetic monitoring work in adverse environmental conditions with a wind speed of more than 5 m/s, in practice the issue of ensuring the continuity of technological processes requires the implementation of geodetic work even when the wind speed and solar heating exceed the established norms.

CONCLUSIONS AND SUGGESTIONS

Thus, based on the above analysis, the following conclusions can be drawn:

1. At high levels of external environmental influences (solar heating, wind shear), the values of torsion and deflection of tower-like structures, including the television tower mast, may exceed the permissible values several times.
2. When performing geodetic work to monitor the deformation of tower-like structures, it is necessary to take into account the influence of the external environment.
3. It is recommended to determine the optimal time for monitoring the deformation of television towers from 500 to 1000 in the morning.

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