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Laying and Protection of Water Pipelines in Conditions of Moving Sands

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Abstract: This article is devoted to the design and construction of settlements in sandy deserts, with an emphasis on creating a protected and comfortable living environment. Key aspects are considered, such as protection from natural factors (sand storms, heat and dust), water supply, as well as effective ways to protect water pipes and buildings from the effects of sand.

Particular attention is paid to the need to create green protective strips and landscaping, as well as recommendations for laying utility networks and water pipes at depth, which minimizes the negative impact of sandstorms. The main architectural and planning solutions are provided, aimed at the sustainability of infrastructure and improving the microclimate in sandy deserts.

Keywords: sandy desert settlements, desert architecture, sandstorm protection, green protective belts, water supply systems, buried utility networks.

Introduction

The construction and operation of structures in areas with shifting sands (deserts, semi-deserts, etc.) presents significant challenges due to the constant threat of sand drifts and soil blowing from the subgrade. Preventing these phenomena and effectively protecting against them in sandy deserts and semi-deserts is often an important economic protection measure, as the proper solution often determines the proper operation of water management facilities.

To characterize the clinical conditions that determine interesting developments in the sandy deserts of Central Asia, primary attention was paid to wind conditions, atmospheric precipitation, air temperature, and air humidity, which influence sand regeneration, soil erosion, and sandy relief formation. Long-term observations over 50 meters of semiautomatic logical stations indicate that the sandy deserts and semi-deserts of Central Asia are characterized by high temperature ranges, low precipitation, and high wind speeds.

In deserts with shifting sands, construction canals (Karakum, Kyzylkum, etc.), water pipelines (Kungrad Kulsary, Amu Darya, etc.), gas pipelines (Central Asia Center, etc.), cities (Zarafshan, Gazli, etc.) and industrial facilities have been built and continue to be built.

The development of the natural resources of the deserts of Central Asia, Kazakhstan, and other regions with shifting sands is inextricably linked with the construction of highways and railways.

After Turkmenistan, the Karakalpakstan region occupies the second largest area of sandy deserts. The Kyzylkum Desert is the main sand massif. It stretches west to east between the middle reaches of the Amu Darya and Syr Darya rivers, from the ancient Zarafshan Valley in the south to the Aral Sea in the north. It occupies the vast Kyzylkum Plateau. Shifting sands are found on the right bank of the Amu Darya River.

Desert sands are classified according to their mobility [1] as mobile, slightly mobile, and immobile.

In sandy deserts, the population of the area serves as a protective factor against adverse natural conditions and is a factor that artificially improves the environment for human life.

Architectural planning solutions should provide protection from hot and dusty buildings; shaded areas and non-exit routes are necessary. In sandy deserts, it is recommended to construct low-rise residential buildings with wide slabs equipped with systems that artificially improve the microclimate.

Water supply is a crucial factor in the construction of settlements and the continued existence of sandy deserts.

To protect settlements from sand drifts, it is necessary to plan a series of landscaping projects and the creation of protective strips around settlements at least 2 km away, while preserving the existing vegetation cover of the sands.

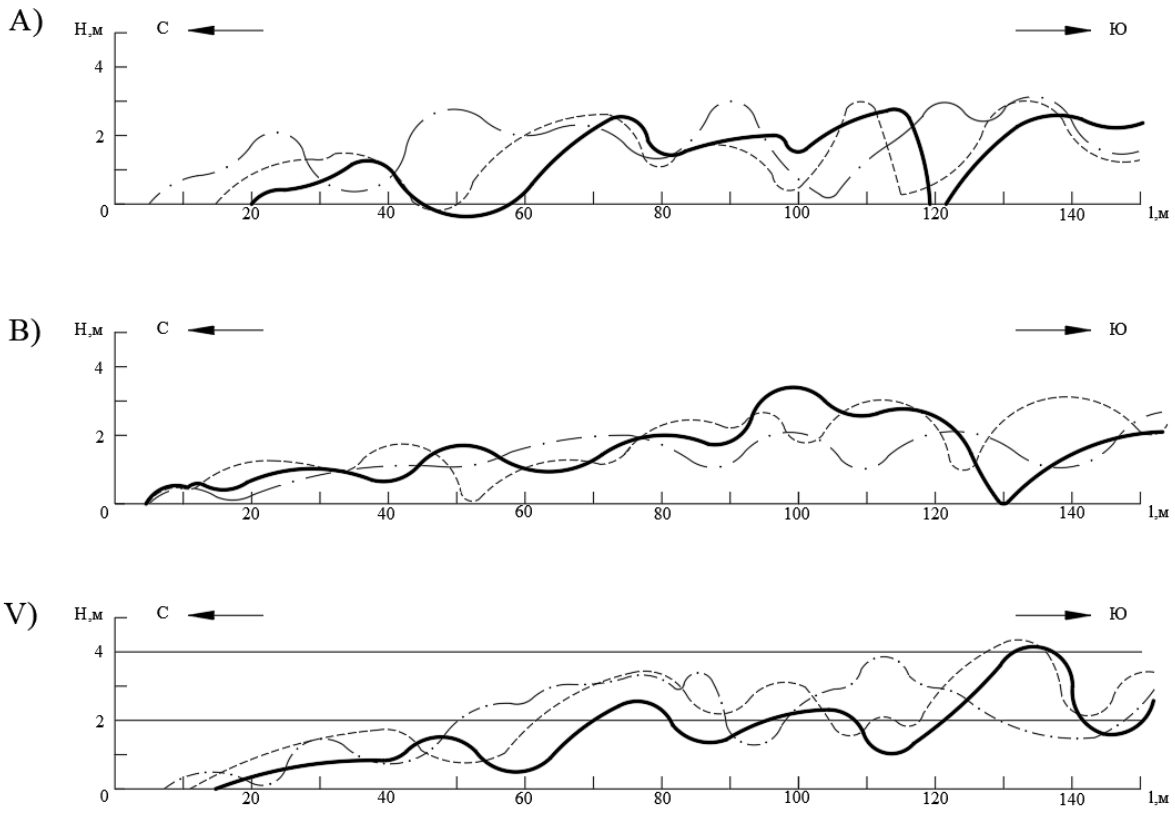
When laying water pipelines and other structures in sandy deserts, the primary objective is to protect them from sand blowing. Above the water pipelines, the disturbance of the sand structure during excavation significantly worsens irrigation conditions for forests. Large masses of sandy soil generated during the construction of the grading strips and pipe trenches also have a negative impact. These sands, moved by the wind, bury mechanical protection systems and vegetation.

A 20-30 m wide tinted strip often serves as the only path through sand during pipeline installation. Therefore, mechanical protection and vegetation are constantly at risk of destruction.

It is recommended that pipelines be laid at a greater depth (1.5-20 m) below the sand surface, graded along the minimum elevation of the pipeline alignment (86). However, this method is only effective if the following rules are strictly observed during design and construction.

- In exposed dune sands, when surveying the water pipeline route, the grade strip should be graded using a level with minimum marks.

- In overgrown sands with sharp elevation changes and steep slopes, if pumps need to be installed during pipe laying, the grade strip must be secured immediately after trenching. (Drawing. 1)



Drawing. 1. Profiles of three dune chains with progressive sand movement, obtained during repeated leveling:

- in velvet sands, the slope angle of the trench walls should be as close as possible to the angle of natural repose of the sand (no more than 35^0)

- During excavation work (straight line planning and trenching), loose sandy soil is moved only to the leeward side of the trench, and for backfilling the trench, soil is removed only from the leeward side, taking care not to disturb the trench walls. The resulting mound of highly loosened sand above the trench is compacted, as too dry conditions prevent settlement and the mound will swell.

Conclusions:

1. **Protection from natural conditions:** In sandy deserts, it is important to design low-rise buildings with wide frames to provide natural shading and improve the microclimate. This may include installations to artificially improve indoor climate conditions.
2. **Water supply issues:** One of the key challenges when building settlements in the desert is ensuring a reliable water supply. A crucial issue is protecting water pipelines from sandstorms, which can bury pipes and impede their operation..
3. **Greening and protective strips:** To protect against sand drifts, it is necessary to create green zones and protective strips around populated areas. This includes landscaping and preserving vegetation, as well as creating a strip at least 2 km wide.
4. **Water pipeline design:** It's important to properly install water pipelines, protecting them from sand drifts. For this purpose, it's recommended to lay pipes at a depth of 1.5–2 m to minimize the impact of sand and wind.
5. **Technical construction considerations:** In sand dune conditions, special attention should be paid to the route profile and slopes where pipes are laid. This will help prevent sand accumulation and improve the longevity of the constructed infrastructure.

This approach aims to create sustainable living conditions and protect people living in such challenging natural environments through an optimal combination of architectural solutions, landscaping, and proper planning of utility networks.

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