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Factor space for construction of pile foundations in permafrost soils

Factor space is a method for determining the relationship between internal and external factors affecting the construction process. Internal factors are the processes controlled by the developer or investor during the realization of a construction project. Internal factors include: planning, controlling, intensity, quality, cost and operational reliability. External factors are conditions that cannot be influenced by the developer or investor during the realization of a construction project. External factors include: natural conditions, permafrost degradation and infrastructure. Analyzing the factor space in the construction of pile foundations on permafrost provides construction companies with the opportunity to achieve the following objectives:

1. Identification of the main factors: factor space analysis allows to identify the main aspects that have the greatest influence on the technological process.
2. Interrelationships between factors: factor space analysis helps to explore the interrelationships between different factors and understand how they interact with each other.
3. Process Optimization: factor space analysis helps to identify opportunities for optimizing processes, materials and resources. This helps in improving the efficiency and quality of pile foundation construction, achieving better results.
4. Risk Management: factor space analysis helps to identify potential risks associated with various factors and develop strategies to mitigate or avoid them. This allows for better management of risks associated with unpredictable permafrost characteristics and other factors affecting the foundation construction process.

Thus, factor space analysis in permafrost pile foundation construction is an important tool for developing optimal strategies and making informed decisions that contribute to successful project implementation.

Keywords: *permafrost soils, factor space, pile foundations*

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INTRODUCTION

Permafrost soil — soil that has been frozen continuously for three or more years[1].

Finding nickel, tin and carbon deposits in the Arctic zone, as well as using the Northern Sea Route to transport cargo from Asia to Europe, opens up prospects for the development of Russia's northern regions.

In order to implement the tasks set in the RF Government Resolution No. 484 dated March 30, 2021, active development of the Arctic zone and improvement of construction technologies are required to increase the efficiency of work production[2] [1].

Pile foundations for industrial tanks in permafrost soils are critical structures, the design and construction of which require special attention. Due to the ambiguous behaviour of the foundation structures during operation, it is necessary to continuously monitor and improve the technology to ensure their reliability[3] [2, 3].

The construction of pile foundations for industrial tanks in permafrost soils is a reliable and cost-effective solution that offers advantages over block and strip foundations. They provide high reliability and durability in operation, making them the preferred choice[4] [4–6].

Factor space is a method that allows to determine the relationship between the factors affecting the construction process [7].

The main purpose of this paper is to construct a factor space, to determine the internal and external factors affecting the construction of pile foundations in permafrost soils.

INTERNAL FACTORS

Internal factors — processes controlled by the developer or investor during the realization of a construction project.

Internal factors affecting pile foundations for industrial tanks in permafrost soils:

- planning, controlling;
- intensity;
- quality;
- cost;
- operational reliability.

Planning during the construction period involves defining objectives, project management techniques and strategy development, and monitoring the realization of the objectives. This includes determining the project's resources, schedule, budget, and requirements, and developing programmes to achieve them. Control involves continuous monitoring of

1 SP 25.13330.2020. Foundations and foundations on permafrost soils SNiP 2.02.04–88. Introduced on 12.30.2020. Moscow, Standardinform Publ., 2021. (rus.).

2 Resolution of the Government of the Russian Federation No. 484 dated 03.30.2021. Approval of the State Programme of the Russian Federation "Social and Economic Development of the Arctic Zone of the Russian Federation" (rus.).

3 Alexeev A.G. Geotechnical monitoring of permafrost soils : study guide. Moscow, ASV Publ., 2019; 112. URL: https://www.rosmedlib.ru/book/ISBN9785432303318.html (rus.).

4 Manual on the organization of construction production in the conditions of the Northern Zone. Moscow, Stroyizdat Publ., 1978; 113. (rus.).

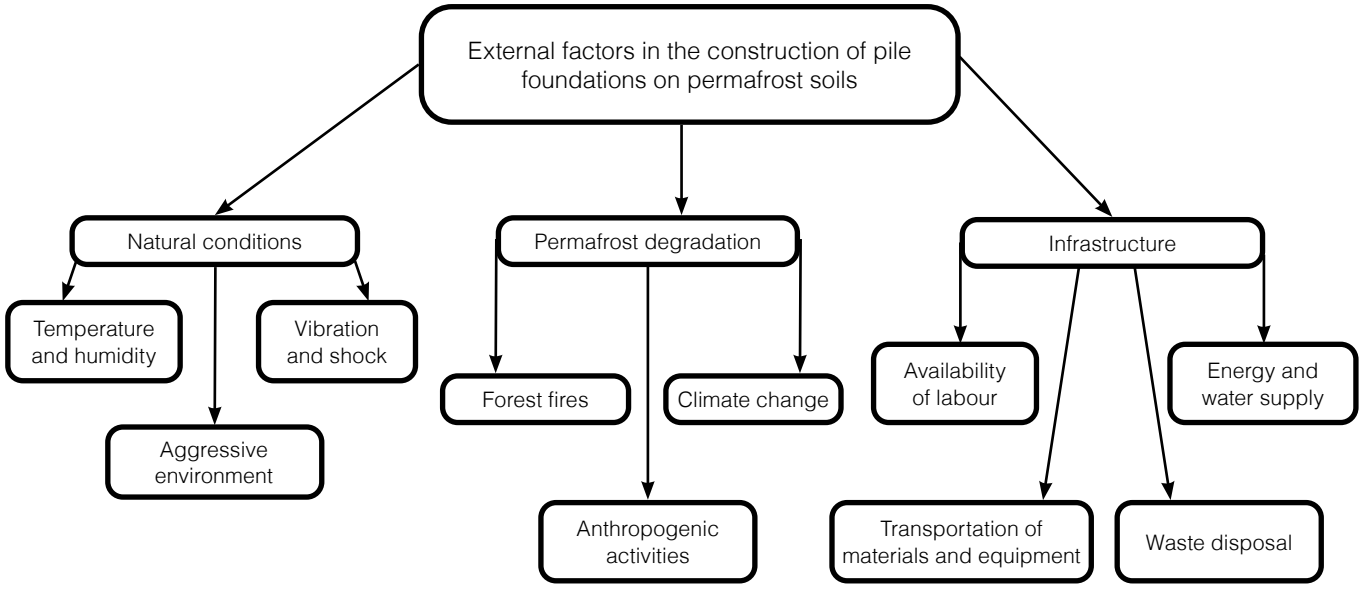

Fig. 1. External factors in the construction of pile foundations on permafrost soils

the plans and taking corrective action when necessary to achieve the objectives. All of this helps to manage the construction process effectively, reduce the risks of delays and budget overruns and improve the quality and efficiency of construction work [8].

Construction intensity is a key indicator of the effectiveness and efficiency of the construction process. It is determined by the amount of work performed at the construction site over a certain period of time. Increasing the level of construction intensity allows to achieve a reduction in the time of work, reduce costs and increase the profitability of the project. Various methods and technologies are used to achieve this goal. Important factors are the use of modern equipment, careful planning and organization of work, optimization of logistics and other approaches.

The concept of quality in construction reflects the degree to which the work performed meets the needs of the customer and complies with the stated requirements, standards and regulations. High quality in construction implies defect-free execution of work, compliance with project deadlines and budget, as well as the use of quality materials and technologies. Excellent quality in construction also includes meeting the customer's expectations and ensuring the safety of the facility.

The concept of cost in construction refers to the total amount of financial resources required to complete a project. This includes the cost of materials, labour, equipment acquisition and use, and other costs including permits and taxes. Costing in construction is important for planning and controlling the project budget, as well as for making financial management and cost optimization decisions.

Operational reliability is the property of an object to remain operable for a certain period of time or operating time under specified conditions of operation and maintenance [9, 10].

EXTERNAL FACTORS

External factors are conditions that cannot be influenced by the developer or investor when implementing a construction project.

External factors affecting pile foundations for industrial tanks on permafrost soils (Fig. 1):

- natural conditions;
- permafrost degradation;
- infrastructure.

Analyzing the factor space in the construction of pile foundations on permafrost allows construction companies to achieve the following objectives [11]:

1. Identify the main factors that have the greatest contribution to the technological process. This helps to identify the main aspects to be considered in project planning and management.

2. Explore the interrelationships between different factors and understand how they influence each other. This enables construction companies to more accurately predict possible impacts and make informed decisions to optimize the foundation process.

3. Optimize factors to improve construction efficiency and quality. Factor space analysis helps to identify opportunities to optimize processes, materials and resources to achieve better results.

4. Manage the risks associated with various factors. Factor space analysis helps to identify potential risks and develop strategies to mitigate or prevent them.

The factor space for the construction of pile foundations in permafrost conditions is presented in Fig. 2.

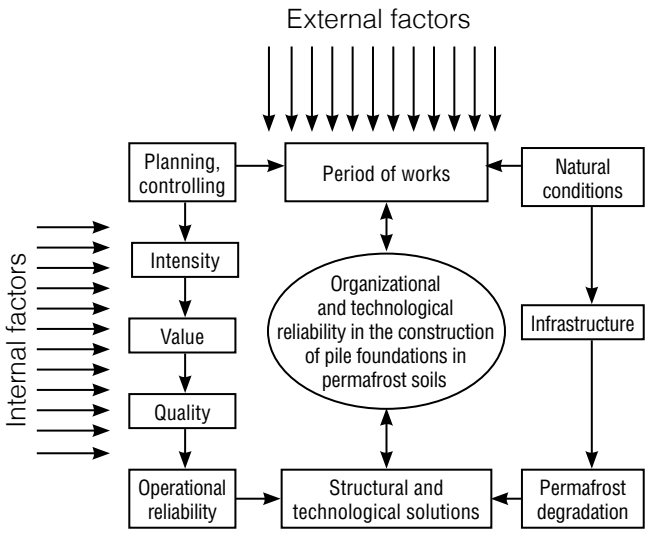

Fig. 2. Factor space for construction of foundations for industrial tanks in permafrost conditions

CONCLUSION

Creating a factor space for the construction of pile foundations in the conditions of permafrost soils makes it possible to optimize the design, ensure safety, increase reliability and improve durability. By conducting a thorough analysis and study of the factor space arising in the construction of pile foundations, it becomes possible to effectively manage risks and successful implementation of the construction project.

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Факторное пространство для строительства свайных фундаментов на многолетнемерзлых грунтах

Факторное пространство — это метод для определения взаимосвязи между внутренними и внешними факторами, влияющими на строительный процесс. Внутренние факторы — процессы, контролируемые застройщиком или инвестором при реализации строительного проекта. К внутренним факторам относятся: планирование, контроллинг, интенсивность, качество, стоимость, эксплуатационная надежность. Внешние факторы — это условия, на которые при реализации строительного проекта не может повлиять застройщик или инвестор. К внешним факторам относятся: природные условия, деградация мерзлоты, инфраструктура.

Анализ факторного пространства при строительстве свайных фундаментов на вечной мерзлоте предоставляет строительным компаниям возможность достижения следующих целей:

1. Идентификация основных факторов: анализ факторного пространства позволяет выявить основные аспекты, которые оказывают наибольшее влияние на технологический процесс.

2. Взаимосвязи между факторами: анализ факторного пространства помогает изучить взаимосвязи между различными факторами и понять, как они взаимодействуют друг с другом.

3. Оптимизация процессов: анализ факторного пространства позволяет выявить возможности для оптимизации процессов, материалов и ресурсов. Это помогает повысить эффективность и качество строительства свайных фундаментов, достигая лучших результатов.

4. Управление рисками: анализ факторного пространства помогает идентифицировать потенциальные риски, связанные с различными факторами, и разработать стратегии для их снижения или предотвращения. Это позволяет более эффективно управлять рисками, связанными с непредсказуемыми характеристиками вечной мерзлоты и другими факторами, влияющими на процесс строительства фундамента.

Таким образом, анализ факторного пространства в строительстве свайных фундаментов на вечной мерзлоте является важным инструментом для разработки оптимальных стратегий и принятия обоснованных решений, способствующих успешной реализации проектов.

Ключевые слова: *многолетнемерзлые грунты, факторное пространство, свайные фундаменты*

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