BIO Web of Conferences **105**, 06008 (2024) https://doi.org/10.1051/bioconf/202410506008
AEGISD-IV 2024

Selecting a modular mining laboratory in the design life cycle

Roman R. Zhuravlev[1*], *Artem* S. Subbotin[2], *Nikita* A. Chabrov[2], and *Daria* A. Vasilieva[2]

[1]Moscow State University of Civil Engineering, Department of Hydraulics and Hydraulic Engineering, Yaroslavskoe sh. 26, Moscow, 129337, Russia
[2]Moscow State Construction University, Department of Thermal and Nuclear Power Facilities Construction, Yaroslavskoe sh. 26, Moscow, 129337, Russia

Abstract. Modular laboratories are becoming increasingly popular in mining operations due to their flexibility, mobility and cost-effectiveness. However, selecting a suitable modular laboratory can be a challenging task as many factors need to be considered throughout the project life cycle. This article provides a comprehensive analysis of the design phase of a temporary research facility, as well as consideration of management and organization to identify the optimal design solution. The authors discuss various project management methodologies such as lean manufacturing and quality management that can help optimize processes and improve efficiency. Key factors such as testing requirements, infrastructure availability, mobility, durability, and environmental considerations are examined. In addition, the article explores the benefits of temporary buildings to permanent buildings in a mining environment. Finally, the authors provide recommendations for selecting a modular laboratory that will provide efficiencies on the shop floor.

1 Introduction

Modular mining laboratories are playing an increasingly important role in supporting mining operations by providing mobile and flexible solutions for testing and analyzing samples. They offer a number of advantages over permanent R&D facilities, including the ability to be rapidly deployed, relocated and scaled to meet changing project needs [1].
The purpose of this article is to select the right modular laboratory, which is critical to ensuring the efficient and smooth running of a mining operation. However, this selection can be complex as many factors need to be considered throughout the project lifecycle. In order to make these design decisions, various project management methodologies such as lean manufacturing and quality management are examined, which can help optimize processes and improve efficiency. In addition, the design phase in the life cycle of a facility is examined, which can show the labor costs of constructing a structure.

* Corresponding author: romazhurawlyow@yandex.ru

2 Peculiarities of design in mining areas

Designing in mining terrain areas has its own peculiarities, in some cases taking on complex geographical conditions and natural features. Some of the main features include:

1. Remoteness and accessibility: Mining areas are often located in remote and inaccessible locations. Modular laboratories should be designed with these conditions in mind, allowing for easy transportation and deployment, as well as accessibility to necessary equipment and materials.
2. Structural strength: due to changing ground conditions, winds, avalanche and earth hazards, additional structural strength and load bearing capacity must be considered.
3. Severe climatic conditions: Mining areas can experience extreme temperatures, high winds, dust and humidity. Modular laboratories must be designed to withstand these harsh conditions by providing proper insulation, ventilation, and protection from the elements.
4. Infrastructure: Due to the complexity of the area, various transportation, communication, and other systems must be designed to function efficiently.
5. Environmental considerations: Mining activities can have a significant impact on the environment. Modular laboratories should be designed with environmental considerations in mind, including energy efficiency, waste management and minimizing impact on the local ecosystem.
6. Safety Requirements: The mining industry has stringent safety requirements. Modular laboratories must comply with all relevant safety codes and standards, including protection against explosions, fire and chemical hazards.
7. Mobility and Flexibility: Modular laboratories should be designed for mobility and flexibility, allowing them to be easily moved and reconfigured as project needs change. This may include a modular design that allows modules to be added or removed as needed.

In general, designing in mining areas requires a unique approach, consideration of many factors and the application of specialized knowledge to successfully implement projects. In this case, it is better to choose a modular building because it can be quickly assembled and installed on site, significantly reducing construction time [2]. In addition, modular buildings can be easily portable and reusable, making them a more economical option. Also, modular buildings typically have a simpler design, making them easier to manufacture and install (Figure 1).

Fig. 1. Installation of temporary modular buildings.

Modular buildings can be constructed from a variety of materials, including steel, concrete, wood and composite materials. Depending on the design and purpose of the building, materials are chosen for their durability, resistance to various weather conditions, energy efficiency and other factors. In recent years, modular buildings based on modern composite materials have become increasingly popular due to their strength, lightness and resistance to corrosion.

3 Selecting a temporary laboratory

Modular buildings are spatial structures consisting of prefabricated modules manufactured in factories and delivered to the construction site for assembly. Modular buildings offer a flexible and quick solution for a variety of construction needs, and they can be environmentally friendly and energy efficient [3].

In the mining industry, modular buildings can be used for a variety of purposes. For example:

1. Modular buildings for offices and administrative facilities: such buildings can be used as offices for the management of mining activities, premises for engineering and technical personnel, as well as for the equipment of safety and technical control rooms.
2. Modular housing complexes: to accommodate workers at the mining site.
3. Modular canteens and dining facilities: for the provision of meals to workers employed in the mining industry.
4. Modular medical centers: to provide first aid to workers and medical care at the work site.
5. Modular storage and warehousing facilities: to store tools, equipment and materials used in the mining industry.

In general, modular buildings can be designed and engineered to meet the specific needs of the mining industry and enable rapid deployment of the necessary infrastructure on site.

The temporary research centers are equipped with advanced technologies to obtain remote information from the research site using sensors and drones. Basically, they will be represented by huts (Figure 2)

Fig. 2. Temporary research complex.

In general, modular buildings can be designed and engineered to meet the specific needs of the mining industry and enable rapid deployment of the necessary infrastructure on site [4].

4 Comparisons of a modular building with a permanent building

However, it can be noted that temporary construction is usually faster than the erection of permanent buildings due to the use of modular elements and standardization of processes. This can be particularly useful in situations where quick access to housing or other types of buildings is required, such as in the case of disasters or temporary events. Moreover, statistics show that temporary buildings can also be more cost-effective as they require less material, labor and construction time (Figure 3). However, it is worth noting that permanent buildings usually have a more durable design and resistance to various impacts, so they remain the preferred option in some cases. Thus, the choice between temporary and traditional buildings in each case depends on a number of factors, such as the purpose of the building use, budget, timing and other conditions.

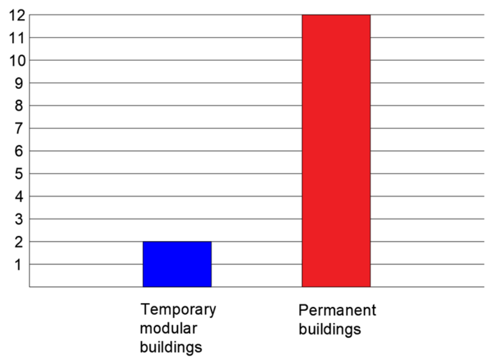

Fig. 3. Diagram of construction installation times for 2 building types.

Another aspect to consider when choosing between temporary and traditional buildings is their impact on the environment. Temporary buildings can be more resistant to climate change as they are often easier to dismantle and reuse materials, while traditional buildings usually remain in place for a long period of time. The heat transfer resistance for modular buildings is determined using the following formula (1):

$$R_{\text{т.тр.}} = \frac{n(t_{\text{в}} - t_{\text{н}})}{\alpha_{\text{в}} \Delta t_{\text{в}}}$$

Where $t_{\text{н}}$ is the design winter outdoor air temperature, °C;

$t_{\text{в}}$- design winter indoor air temperature, °C

n - a coefficient that takes into account the position of the outer surface of the building envelope in relation to the outside air;

$\alpha_{\text{в}} \Delta t_{\text{в}}$ - the calculated difference between the temperature of the internal air and the temperature of the internal surface of the building envelope, °C.

Therefore, in situations where it is important to reduce the negative impact on the environment, as well as to quickly erect a building in extreme conditions temporary structures may be a more preferable option.

5 Management and organization

These centers will be the base for geological research, collecting samples and sending them to the main scientific center for further testing and identification of soil characteristics. Geological surveys play a key role in the design and construction of any buildings, including modular buildings [5]. They provide information on soils, geological structure and terrain features, which is necessary for determining foundations, selection of materials and technical parameters of the building structure. For example, data on soils will help to determine the necessary depth and type of foundation for a modular building, to take into account the peculiarities of soil stability when choosing the location. Thus, geological surveys significantly affect the design, construction and durability of modular buildings. There are several main stages of the SGI:

1. Exploration of mineral deposits. At this stage, geological research and evaluation of mineral reserves are carried out [6].
2. open pit or underground development of deposits (Figure 3). At this stage, mineral extraction, drilling and blasting, excavation and transportation of rock mass are carried out.
3. ore enrichment. This stage includes various technological processes aimed at enrichment and processing of ores to obtain final products.
4. Processing and smelting of products. At this stage, mineral raw materials are processed, refined, treated and smelted to produce metals.
5. Manufacturing of final products. This is where final goods are manufactured from mined and processed materials.

Fig. 4. Sampling from the well (core).

Thus, the study demonstrates the importance and relevance of electrical refueling infrastructure development in rocky soil conditions, and the solutions proposed by the authors can serve as a basis for further development and implementation of new technologies in this area.

6 Conclusion

Research centers in mining areas are an integral part of production as they improve efficiency, workflow and organization. This article provides valuable guidance for mining companies seeking to optimize the selection of a modular laboratory and ensure its efficient operation throughout the project life cycle. Possible design solutions have been identified from the research, as well as comparisons of different types of buildings

References

1. A.S. Subbotin, R.R. Zhuravlev, V.V. Vasilevskiy, I.S. Kulagin, E3S Web of Conferences **390**, 03013 (2023)
2. A.S. Subbotin, D.I. Konchakov, E.A. Karavashkina, D.B. Dolzhko, Transportation Research Procedia **68** (2022)
3. A. Dostovalova, V. Smirnova, E3S Web of Conferences **135**, 03013 (2019)

4. A.S. Subbotin, F.A. Blagoveshchensky, E.F. Bukina, *Architectural constructions* (Moscow, Architecture C, 2011)
5. R.A. Mangushev, V.D. Karlov, I.I. Sakharov, A.I. Osokin, *Foundations and footings* (DIA; SPb., SPbGASU, 2014)
6. I.S. Ukrainsky, A.V. Kamenchukov, A. B. Pavlikov, *Engineering Geology* (Pacific State University, Khabarovsk, 2022), p. 203