Design solutions for construction of auto-electric refueling stations in the conditions of rocky soils

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Abstract. In today's world, the electric car is no longer a fantasy, but an ordinary vehicle that also requires a battery charging station. This is impossible without infrastructure development, especially in mountainous and rocky regions. The appearance of electric charging stations on public roads shows the development of the region, which affects the transportation system, namely its expansion and demand. Despite their simplicity, buildings on rocky soils are difficult to design and require special engineering solutions. The structures themselves should act, as one of the ideas of the electric car, as a picture of ecology, that is, they should be made of eco material and not harm the environment with harmful vapors and waste. If we take apart the design of electric refueling station, the charging stations can act not only as a place to replenish the charge to the battery, but also points of interest, such as: observation decks, places for recreation, etc., as well. Overall, the information raised in this article may help the future of the construction industry as possible designs will soon become ubiquitous.

1 Introduction

The main task of mankind in the modern world is considered to be the improvement of comfortable living environment. To develop the standard of living, we develop infrastructure and make benefits more accessible [1]. Vehicles running on internal combustion fuel emit harmful substances into the atmosphere that reduce life expectancy. The modern environmental community has set out to combat consumerism, so electric cars have gained momentum as pollution-free transportation and help develop infrastructure in this direction. However, when operating eco-transportation, we are faced with the problem of charging cars. The problem of charging cars can be solved by the construction of electric filling stations on highways, but the construction of electric filling stations requires an understanding of the conditions under which construction and installation works will be carried out [2]. In mountainous regions there are problems with this, as the construction of buildings depends on the development of road systems.

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2 Construction conditions in mountainous terrain

Building structures on steep slopes is not an easy task. It requires a number of studies and non-standard solutions in the construction of the structure. Especially we would like to emphasize the difficulties in foundations, one of the most important elements of construction. In mountainous terrain, as a rule, before dulling to erect a structure, we must conduct a number of geological surveys.

The mountain climate is very unpredictable; it rains in the morning, the sun shines at lunchtime, and in the evening, it rains. Also, the very sharp temperature difference (day-night), in turn, gives its own complications in construction on mountain soil. These are some of the reasons for the difficulty of construction. Soils such as clay, loam, loamy loam and peat are easily deformed by moisture and low temperatures. An important stage on rocky soils is to underpin the site for the projected construction. One of the favorable places of erection is a dry and high site, which has a number of advantages [3]

1. Preventing flooding: locating the building on a high site reduces the risk of flooding in the event of rainfall or flooding
2. Efficient drainage: on a high site it is easier to organize a drainage system. This avoids water stagnation around the building and reduces the risk of foundation failure.
3. Simplification of the system with sewage: creating a sewage system becomes more efficient when the building is located on an elevated site. Gravity drainage of wastewater becomes simpler, reducing the need for additional pumps and mechanical means for drains.
4. Reduced maintenance costs: development on a high and dry site can reduce the cost of regular maintenance and repair of utility systems due to reduced exposure of the building to water and moisture.

Of all the features, the structures, namely the foundations, should be chosen thoughtfully. Foundations for mountainous terrain are difficult to select due to the difficult terrain (Figure 1).

	Strip foundation	Column foundation	Slab foundation
assembly speed	slowly	quickly	slowly
reliability and durability	durable	durable	durable
soil tolerance	unpretentious	unpretentious	requires sand preparation
simple technology	Requires a specific methodology	Easy to install	Easy to install
economical	dearly	average	dearly

Fig. 1. Disassembly of foundations.

3 Engineering-geological peculiarities of rocky soils

The geology of the mountainous area is characterized by the presence of various rocks and geological structures that reflect the complex formation history of the region. Both ancient crystalline rocks and younger sedimentary and volcanic formations can be found in the region.

Rocky soils differ from other types of soils in their density and strength due to the presence of large amounts of mineral material in them. They are formed from rocks such as granite, basalt, limestone, etc.

1. Strength: Rocky soils are characterized by high strength compared to other types of soils. They are composed of hard materials such as rocks, minerals, etc.
2. Heterogeneity: Rock soils can be very diverse in their structure, composition and characteristics. This can range from quarried stone to clayey, sandy or limestone rock.
3. Porosity and filtration: Rock soils have different porosity and filtration, which is important for evaluating their hydrogeologic properties.
4. Tectonic faults and fractures: Rock soils often contain cracks, fractures and other defects in the structure, which can affect their strength and stability.
5. Treatment and Use: Rock soils are used for a variety of purposes, including the construction of roads, tunnels, dams, building foundations, and other facilities. However, the processing of such soils requires special techniques and equipment.
6. Geological investigations: for proper design and construction of facilities on rocky soils, it is necessary to conduct comprehensive geological investigations to evaluate their properties and structure.

Engineering and geological features of rocky soils play an important role in the design and construction of structures in such areas [4]. They must be considered during geological and engineering studies to prevent possible risks and to take the necessary measures to ensure safe operation of structures.

4 Engineering-geological peculiarities of rocky soils

In mountainous terrain, post and pile foundations are chosen most often for several reasons:

- Topographical features: The mountainous terrain is characterized by a complex relief with a large height difference and the presence of steep slopes. Pillar foundation with piles allows to create reliable structures on slopes, ensuring their resistance to wind and seismic loads.
- Climate: Upland areas experience high winds and high humidity, which can have a negative impact on the condition of the foundation. A post and pile foundation with piles provides greater stability and resistance to climatic conditions.
- Geologic conditions: In mountainous areas there are often mobile soils that require a special approach to the choice of foundation type. A post-and-pile foundation with piles can provide reliable support on such soils, preventing their subsidence and deformation.

In addition, the use of a pile foundation can reduce excavation costs and speed up the construction process, which is an important factor in mountainous terrain. It is not always possible for piles to be buried deep in mountainous soils, so other design solutions should be considered [5]. The best alternative to a pile foundation on rocky ground would be a shallow post foundation (Figure 2).

Fig. 2. Shallow post foundation.

Special equipment is used to make shallow boreholes, after which poles or monolithic structures are installed. They can be supplemented with extensions on the rings to make them more secure. Due to their high durability, it is not necessary to make deep wells. They are not afraid of seasonal swelling and other pushing forces.

5 Architectural solutions

The relevance of the architectural component of an electric vehicle filling station is confirmed by the ecological message of the electric vehicle concept itself. It is recommended to use eco materials with proven fire resistance and dielectric properties that are safe, i.e. exclude the spread of accident consequences (Figure 3).

Fig. 3. Concept of an electric refueling station.

It is recommended to use reinforced concrete structures as the skeleton of the building for greater emotional expression (with guidelines for their subsequent disposal), as such structures are the easiest to give the desired shape (Figure 4). In the basis of insulation should be only natural fiber and natural components, such examples are: ecowool, cork insulation, peat blocks, linen insulation. For the interior decoration of the building the best option will be cork - a clean material that does not burn and does not sink, does not cool and does not glow, has excellent insulating properties, does not enter into chemical reactions and does not pass water, sound and electricity [6]. The gas station eco-advocate will also welcome furniture made from recycled plastic.

Fig. 4. Possible design solution.

Since waiting for the car to be fully charged by means of electric charging is a long event, it is worth providing rest areas for visitors, and, since the conditions of rocky soils imply the presence of mountainous terrain, it will be advisable to arrange a viewing platform.

6 Architectural solutions

In this study, we have considered the design and construction of electric vehicle refueling stations in rocky soil conditions. We analyzed the peculiarities and difficulties associated with the development and implementation of such projects, and proposed a number of engineering solutions for the successful operation of facilities on difficult soils. One of the key points in ensuring the safety and efficiency of electric refueling stations is the use of environmentally friendly materials and technologies that do not harm the environment. In this context, the authors emphasize the importance of using eco-materials in the construction and operation of such facilities. The design solutions proposed in the study can be used to develop transportation systems in mountainous and rocky regions and improve infrastructure for electric vehicles. The development of an EV refueling network will contribute to increasing the availability and popularity of electric vehicles, as well as improving the environmental situation in the region.

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.

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