Horizon | Journal of Humanity and Artificial Intelligence

Volume 4, Issue 1 | 2025
ISSN: 2835-3064
https://univerpubl.com/index.php/horizon

Article

Effect of Transport Loads on Road Foundation

Makhmudova Dilfuza Abdulazizovna*[1]

1. Tashkent State Transport University, Tashkent, Uzbekistan
*Correspondent: dilfuz240570@mail.ru

Abstract: The research analyzes the influence of transport-created dynamic loads that affect loess soil foundations in Uzbekistan's roads. Few researchers understand the stress distribution along with the deformation behavior of loess subgrades after vehicle load cycles in environments with changing soil moisture content. Through theoretical mathematical modeling and stress distribution modeling techniques the study analyzes how static along with dynamic load varieties affect soil strength parameters and cohesion parameters and result in deformative actions. Research demonstrates that proper embankment thickness minimizes dynamic loads yet poor compaction together with high groundwater conditions causes area failures and enlarges settlement while harming road infrastructure longevity. This investigation demonstrates the fundamental role that moisture distribution together with load-induced stress must play in pavement design processes. The findings generate key practical consequences for transport infrastructure durability in dry regions by demonstrating to engineers that they should optimize soil compaction measures while adding dynamic force variables to their foundation design process. Research should continue by conducting experimental tests on real traffic conditions with new material investigation to reinforce water-sensitive roadbeds.

Keywords: Humidity, Soil, Moisture Accumulation, Roadbed, Humidification, Road Clothing, Transport Load, Voltage

Citation: Abdulazizovna, M. D. Effect of Transport Loads on Road Foundation. Horizon: Journal of Humanity and Artificial Intelligence 2025, 4(1), 32-35.

Received: 28th Mar 2025
Revised: 5th Apr 2025
Accepted: 12th Apr 2025
Published: 18th Apr 2025

1. Introduction

Loess soils are widespread in the territory of the Republic of Uzbekistan. In most cases, they serve as a foundation for transport structures, as well as a building material when constructing earthen floors [1]. The durability of highways depends on many factors. The main factor is the correct design of the calculated characteristics of the earthen floor soils. It is known that the earthwork consists of two parts: the upper - working layer, the lower - non-melting and melting parts [2]. The working layer of the earthwork is under the influence of a movable load, as well as a water regime. Analysis of the results of studies on the influence of the water regime of the earthen floor on the strength of road surfaces leads to the conclusion that in the conditions of Uzbekistan, especially in irrigated areas, the main source of moisture in the working layer is groundwater, the regime of which is closely related to the irrigation regime [3]. In this case, the moistening mechanism is primarily associated with the capillary rise of water. Moisture content of loess soils is the most important characteristic of their state, determining strength, deformation, and settlement properties. The above allows us to determine the strength and deformation characteristics of the soil of the working layer in the conditions of Uzbekistan, depending on the properties of the soil, its state relative to density and moisture, as well as the groundwater level [4]:

$$E=f_1\ (K_u, K_{uv}, I_p, Wp)$$

$$C=f_2\ (K_u, K_{uv}, I_p, Wp)$$

$$\varphi=f_2\ (K_u, K_{uv}, I_p, Wp)$$

Where E - modulus of soil elasticity, MPa; S - specific soil cohesion, MPa ◎ - angle of internal friction of the soil, degrees KU - compaction coefficient, characterizing the density of compacted soil, KUV - moisture coefficient (soil moisture during compaction), characterizing the structural features of the soil of the working layer, Ip -plasticity number, characterizing some indicator of soil composition, WR - calculated humidity [5].

2. Materials and Methods

The highway represents a single engineering complex, all elements of which work in close interconnection. In addition to the above factors, a moving load also affects the earthwork constructed from loess soil. The moving load from vehicles transferred from automobiles to road clothing is transferred to the earthwork. The earth bed should serve as a reliable foundation for road pavement, ensuring its strength and durability regardless of local hydrogeological, soil, climatic, and other factors [6]. If, under the influence of short-term and repeated loads from moving vehicles, they maintain their integrity and uniformity throughout their service life, the earthen linen and road clothing are considered durable. Transport and operational characteristics, as well as the type of pavement and all elements of the road structure, should not change along the entire length of the route. The following requirements are imposed on the road structure: the foundations of the road surface must be stable, the subsidence of the foundation during the operation period must not cause unacceptable distortion of the longitudinal and transverse profiles, elastic deflections and vibrations of the structure from static and dynamic impacts must be limited by the conditions of long-term durability of the road pavement. These requirements determine the main criteria for calculating road structures with loess soils based on the earthwork [7].

The nature of the impact of a movable load (from a car) on the load base is generally much more complex than the impact of a static load from the load's own weight. The study of the influence of a movable load on a pile base shows that the influence of this load can manifest itself in two ways: Similar to the influence of some additional static load or in the form of a certain dynamic effect, causing oscillations of the pile along with the base. In the first case, the consequence of the impact of a movable load may be additional subsidence of the base or violation of the stability of the base during the joint action of a constant and temporary load. Consideration of the moving load in this case should be reduced to solving problems with a quasi-static load. In the second case, taking into account the dynamic effect is related to solving a dynamic problem that considers the impact of emerging pressure fluctuations on the strength and durability of road surfaces [8].

To judge the influence of a moving load on the basis of a load under the conditions of a static problem, first of all, it is necessary to have an idea of the magnitude of the stresses that can arise on the basis of a load from this load [9]. Such an analysis, performed on the basis of some simplifications, gives the following expressions for determining stresses from a moving transport load.

With a tracked load (characteristic of economic and quarry roads):

$$p_n^{\Gamma} = \frac{\sigma_0}{0{,}75v + 0{,}3}\left[n - \frac{\sum_1^{n-1} L_i}{b\,(1{,}5v + 0{,}60)}\right].$$

Where σ_0 - surface load, $v=h/b$ - relative thickness of the deposited layer, b - track half-width, Li-distance from the axis of the design track to the axis of each adjacent track, n - the number of tracks on the crossbar [10].

At wheel load:

$$p_n^{k} = \frac{1{,}33P_0}{(1{,}5h + 0{,}3D)^2}\left[n - \frac{\sum_1^{n-1} L_i}{1{,}5h + 0{,}3D}\right].$$

Where R_0 - load on the wheel; n - the number of wheels acting on the stress state at a given point, h - thickness of the deposited layer, Li-distance from the axis of the ith wheel to the considered vertical, D - Diameter of the wheel imprint [11].

3. Results and Discussion

The obtained expressions show that the stresses from the moving load under the conditions of the static problem, taking into account the real parameters of modern vehicles, can quickly shrink and, at some thickness of the applied layer, turn out to be sufficiently small compared to the stresses from the own weight [12]. Already, in this regard, it can be concluded that with some thickness of the embankment layer, the influence of the moving load may not be taken into account in the calculation of the embankment base. In this case, it is necessary to take into account the possible nature of the influence of the movable load on the foundation: - the movable load may cause a violation of the strength of the foundation soil; - the movable load may cause some additional compaction of the foundation soil; - the movable load may cause large elastic deformations of the pile foundation [13].

The influence of a movable load on the breaking of the foundation's soil strength can manifest itself doubly. First of all, a local violation of soil strength can be observed in zones located directly under the rolling strip, since there is a jump in the load diagram in these zones. At the same time, the movable load can contribute to breaches in the strength of the soil in deeper lyers, where dangerous tangential stresses arise from the weight of the rock mass. In this case, the impact of the temporary load can be considered as some additional increase in the weight of the load, for example, due to an increase in its height [14]. Analysis leads to the conclusion that the greatest influence, both from the point of view of breaking the strength of the soil and from the point of view of its settlement, can be exerted by the moving load during the construction of the earthwork [15].

The influence of the movable repeated load is less the thickness of the load. Therefore, by assigning the corresponding thickness of the drift, it is possible to practically exclude the influence of the moving load on the basis of the drift during its operation.

4. Conclusion

The findings of this study emphasize that moving transport loads, particularly when combined with elevated groundwater levels and soil moisture, critically affect the strength, deformation, and stability of loess-based road foundations. The proposed expressions for determining stress from moving loads reveal that, under certain embankment thicknesses, the impact of dynamic loads may be minimized or rendered negligible in structural calculations. However, where embankment layers are insufficient, the moving loads can induce local failures, increased settlement, and loss of cohesion in the subgrade, especially in moisture-susceptible loess soils. These insights carry significant implications for the design and maintenance of road structures in Uzbekistan and similar geoclimatic regions, suggesting that accounting for both static and dynamic factors is essential to ensure long-term pavement durability. Furthermore, the research underscores the necessity of optimizing embankment thickness and compaction parameters to mitigate these effects. Future studies should focus on experimental validation of the stress distribution models under real traffic conditions, the impact of cyclic loading over time, and the effectiveness of reinforcement techniques using innovative materials to further improve the resilience of subgrade structures in variable environmental settings.

REFERENCES

[1] Z. Davronov and S. Norov, *Ta'limda kompetentlikka asoslangan yondashuv: nazariy asoslar va amaliyot*. Toshkent: Ta'lim nashriyoti, 2018.

[2] P. V. Shvedovsky, V. V. Luksha, and N. V. Chumicheva, *Surveying and Design of Highways, Part 1. Alignment. Earthwork*. Minsk, Moscow: Novoye Znaniye, INFRA-M, 2015.

[3] D. A. Makhmudova, "Study of the water-heat regime of the earthen road surface," *Universe Tech. Sci.*, vol. 5–2 (86), 2021. [Online]. Available: https://cyberleninka.ru/article/n/issledovanie-vodno-teplovogo-rejima-zemlyanogo-polotna-avtomobilnyh-dorog

[4] D. A. Makhmudova and F. K. Ikramova, "Reinforcement of the earthen floor using innovative materials based on basalt," *Universe Tech. Sci.*, vol. 12–2 (81), 2020. [Online]. Available: https://cyberleninka.ru/article/n/ukreplenie-zemlyanogo-polotna-s-pomochyu-innovatsionnyh-materialov-na-osnove-bazalta

[5] B. M. Das, *Principles of Geotechnical Engineering*. United States, 2010.

[6] U. Raxmonov, *Pedagogik innovatsiyalar va ularning o'qituvchilarning professional rivojlanishiga ta'siri*. Toshkent: Akademnashr, 2021.

[7] A. G. Renatovna and A. S. Renatovna, "Pedagogical and psychological conditions of preparing students for social relations on the basis of the development of critical thinking," *Psychol. Educ. J.*, vol. 58, no. 2, pp. 4889–4902, 2021.

[8] A. K. Larionov, *Methods of studying soil structure*. Moscow: Nedra, 1971.

[9] A. Kholmukhamedov, *Innovatsion pedagogik metodlar va ularning Ta'lim tizimida qo'llanilishi*. Toshkent: O'zbekiston Respublikasi Ta'lim Vazirligi, 2020.

[10] D. Makhmudova and F. Ikramova, "Influence of the water regime on the soils of highway substrates," *AIR Conf. Proc.*, vol. 2612, no. 1, p. 040024, 2023.

[11] A. D. Kayumov and D. A. Makhmudova, "Influence of cyclic short-term loads on the physical and mechanical properties of compacted loess soils," *Sci. Technol. Road Ind.*, vol. 04, p. 40, 2019.

[12] W. Kuhn, *Fundamentals of Road Design*. Ashurst Lodge, Ashurst, Southampton, SO40 7AA, UK.

[13] A. Kayumov, R. Khudaykulov, D. Makhmudova, and D. Kayumov, "Impact of repeated loads on saline soil soil roadbed," *E3S Web Conf.*, vol. 264, 2010.

[14] I. E. Yevgenev and V. D. Kazarnovsky, *Earthwork of Roads on Weak Soils*. Moscow: Transport, 1976.

[15] G. R. Akramova, "Development of students' critical thinking in the process of continuous education," *Obrazovanie cherez vsyu Jizn Neprerivnoe Obrazovanie V interesax ustoychivogo razvitiya*, vol. 2.13 (eng), pp. 359–360, 2015.