COMPACTION OF LOESS BASES OF BUILDINGS AND STRUCTURES, AS WELL AS BULK SOILS AROUND THE FOUNDATION USING VIBRATORY ROLLERS IN SEISMIC AREAS

Khakimov G. A.
g. m.f.n., dos.

Samiyeva Sh. Kh.
Doctoral Student (PhD)

Muminov A.A.,
Senior Teacher

Berdimurodov A.E.,
Muminov J.A.
Assistant
(Uzbekistan, Tashkent Institute of Architecture and Construction)

ANNOTATION

This scientific article discusses the sequence of the process of compaction of loess foundations of buildings and bulk soils around the foundation in seismic areas, using vibratory rollers. The recommendation on vibration compaction of loess bases of buildings and bulk soils around the foundation in seismic areas is given. These recommendations can be used to increase the density and associated strength indicators of moistened loess soils lying within the compressible thickness of the base, the value of which does not exceed 2.0-3.0 m, as well as for bulk soils layered around the foundation.The developed recommendations on vibration compaction of foundations and bulk soils around the foundation give a good result in the plan under consideration for structures characterized by a load intensity up to P = 0.15-0.20 MPa. It should be noted that in the conditions of Central Asia, in particular Uzbekistan, where additional deformations (seismic subsidence) may occur in the foundations and around the foundations of buildings and structures, the method of compaction of soils using vibratory rollers is the most reliable way to prepare the foundations of buildings and structures.

Keywords: building; foundation; foundation pit; soil; loess soil; bulk soil; soil density; soil moisture; compaction; vibration roller; vibration compaction; seismic areas.

INTRODUCTION

Currently, soil compaction is carried out by one of the well-known methods, using static rollers, heavy rammers, explosion, with preliminary soaking, vibration compaction (using trailed and self-propelled vibratory rollers), etc. Based on the conditions of the problem, the greatest interest for our research is vibration compaction by rollers. Vibration compaction by rollers is widely used in the practice of hydraulic engineering and road construction. Compaction of soils with vibratory rollers is one of the most responsible operations of the process of erecting dams, dams, embankments, earthwork, as it determines to a large extent the strength and durability of structures, road and airfield coverings. This method of soil compaction can also be used in the preparation of foundations for low-rise buildings, especially in rural areas, where the depth of the foundations and the active zone of deformation from the weight of buildings is small due to the insignificance of the transmitted pressure on the ground.

In modern construction for vibro-compaction of soils, the most diverse mechanisms are characterized by suspended, trailed and self-moving vibro-compilers of surface and deep impact on the soil during operation. Among them, self-propelled vibrating rollers are most often used: XD-120, XD-130, YZC-10, YZC-12, AV110-X, AV115-2(Germany); 434D, 534D(USA); LTC212, LTC210, XG6141D, XG6131(China); SW800, SW850, SW900(Japan); MC-47, DU-10, DU-10A, DU-25, DU-34, DU-36, DU-47, DU-54, DU-57, DU-62(Russia) and trailed vibration rollers: DU-94, DM-08, MS-70 PVC-70, PVK71, SPVK51(Russia); SVAW4, SVAW8, SVAW12(Germany); CatCS10GC, CatCS54B, CatCS11GC, CatCS78B, CatCS79B, etc.

To achieve maximum compaction of the soil, it is very important to choose the most effective methods and means of mechanization that ensure high quality, productivity growth, etc. When choosing machines, it is necessary to focus on mechanized means manufactured by our industry in series, as well as on equipment supplied to Uzbekistan from abroad.

High quality and productivity of soil compaction is ensured with the correct choice of the method of production of soil compaction works, the type of soil compaction machines and parameters.

When choosing the method of compaction of soils and the type of soil compacting machines, it is necessary to take into account the properties of the compacted soil (granulometric composition, humidity, degree of uniformity, etc.), its required density and the timing of work.

Vibrating rollers, operating on the principle of dynamic action on the compacted soil mass, provide a greater depth of the compacted layer and increase productivity when laying soils compared to static rollers. Vibratory rollers can be compacted soils of all kinds, they are applicable in the construction of hydraulic engineering and industrial buildings and structures, laying various pipelines, road and airfield coverings, the device of irrigation channels, etc.

As noted above, vibratory rollers can be used in the preparation of the foundations of low-rise buildings, as well as for compaction of soils lying around the foundation, In this case, trailed vibratory rollers and self-propelled vibratory rollers can be used relatively effectively, capable of compacting soils of both undisturbed and disturbed structures.

LITERATURE REVIEW

The process of vibro-compaction of soils has been studied by many scientists, in particular D.D.Barkan, P.L.Ivanov, G.N.Popov, N.D.Krasnikov, V.A.Ershov, M.Yu.Abelev, M.K.Neklyudov, L.M.Cherkasov, I.U.Albert, H.Z.Rasulov, E.S.Pesikov, G.A.Khakimov, etc. The analysis of literary sources shows that there is no question in terms of our task in a generalized form.The method of vibration compaction using vibrating machines is the most effective for increasing the strength of bulk soils, when filling them in small layers. However, as our field studies have shown, vibration compaction can also be used for compaction of soil and undisturbed structure. In this regard, recommendations are given below on vibration compaction of the foundations of low-rise buildings that make up the main development of rural areas of the Central Asian region, as well as on vibration compaction of bulk soil laid to fill the pit around the foundation.

MATERIALS AND METHODS

Special field experiments were conducted with loess loams at the construction site. To conduct experimental research in the field, a vibrating machine, a trailer vibration roller SVAW-12, manufactured in Germany, was mainly used. Trailed vibratory rollers, manufactured in Germany, have three modifications depending on the type of roller, differing in weight. The SVAW-12 vibrating roller is characterized by the following technical indicators:6 diameter-2.0 m, width-2.0 m, weight-12 tons, operating speed-1.5-5.0 km / h, specific static pressure-59 kg / cm2, exciter force-36 tons, vibration frequency up to 25 Hz. The methodology of the experiments is given in detail below.

RESULTS AND DISCUSSION

The author compacted loess subsidence soils in the base, as well as those lying around the foundation of two-storey residential buildings in the village of Miraki in the Shakhrisabz district of the Kashkadarya region of Uzbekistan with the help of vibrating rollers. The soils of the base are represented by loess-like loams and sandy loams. In natural composition, soils are characterized by: the density of dry soil is 1.38-1.40 t / m3, humidity is 13-15%, porosity is 48-49%. The strength characteristics in the water-saturated state were equal to C (soil adhesion force) = 0.020-0.025 MPa, φ (soil internal friction angle) = 22-23^0. The project, developed by the institute “Uzgiprovodkhoz” (Uzbekistan), provided for the elimination of subsidence properties of the soils of the foundations of buildings by soaking the thickness, followed by compaction with rammers, and compaction of the soils lying around the foundations with manual rammers. In agreement with the construction organization "Gissarakgidrostroy", the Ministry of Land Reclamation and Water Management of Uzbekistan (the Ministry of Agriculture and Water Management of Uzbekistan), it was decided to compact the soils of the bases, as well as the vibratory rollers lying around the foundations of residential buildings. The method of compaction of loess soils of the foundations of buildings, as well as bulk soils around the foundation consisted of the following processes.

1. A pit with dimensions of 61 x 13 x 4.5 m (design dimensions of 60 x 12 x 3.0 m) and a trench (3.0 m wide) were torn off to insert a vibrating roller into the pit.
2. After the excavation was torn off, its bottom was leveled with a bulldozer.
3. Additionally, soil samples were taken and the density-humidity of the soil was determined.
4. The soils were compacted in a combined way at natural humidity immediately after the separation and the layout of the pit to prevent them from drying out. First, the soils were compacted in natural conditions (in undisturbed form). A layer of soil with a thickness of 0.3 m was filled over them (to reach the design mark) and compaction was carried out.
5. The SVAW-12 trailer roller was used to seal the soils of the foundations of the structures.
6. The soils were compacted at the maximum vibration frequencies (f= 24-25 Hz) of the roller.
7. The speed of movement of the vibrating roller is determined by the formula :

$$V=0.2\sqrt{f}=0.2\sqrt{25}=1\text{км/ч}$$

8. The number of passes of the vibrating roller on one track was taken 6-8 times.
9. The compaction was carried out by successive passes of the vibrating roller over the surface of the pit. The overlap of the sealing strip of the previous passage, during the subsequent

passage, was 0.10-0.15 m. Previously, the soil was rolled with 1-2 passes of the roller without vibration.

10. When compacting the soil, the pit was divided into two parts. Such a separation was necessary for turning the vibrating roller, i.e., when the first half of the pit was compacted, the second served as an area for turning the vibrating roller and vice versa.

11. After the soil compaction was completed, samples were taken with double or triple repeatability every 20-25 cm in depth.

12.After compaction, the strength parameters in the water-saturated state were equal to φ=29^0-30^0 (initial 22-23^0) and C=0.040-0.045MPa (initial 0.020-0.025 MPa).

13. The average density of dry soil at the depth of the compacted layer was 1.66 t / m ^ 3, which indicates the complete elimination of subsidence properties (the initial density of dry soil is 1.38-1.40 t/ m3).

14. The soils around the foundations are compacted in layers using a small-sized self-propelled vibrating roller DU-1OA.

15. Soils with a sinus width of up to 1.4 m were leveled with layers of a given thickness manually.

16. With a sinus width of 1.4 m or more, the soils were leveled using a small-sized bulldozer based on a T-54V tractor.

17. At the beginning, the soils were compacted with manual electric rammers IE - 4505 (up to the width of the sinuses 1.1 m), and then with vibratory roller strokes.

18. Loose, layer-by-layer compacted soils had humidity W = 13-14%, which is less than optimal (W_0 = 15%). Because of this, the thickness of the compacted soil is reduced and assumed to be 0.25 m

19. The number of passes of the vibrating roller in one village was taken 6-8 times.

20.After the compaction was completed, samples for density and humidity were taken from each soil layer.

21. The average density of dry soil in the depth of the pit (in the zones bordering the structure) was 1.65 t/ m ^ 3.

Thus, the foundations of four two-storey residential buildings were prepared.

CONCLUSIONS

The results of field and laboratory experimental studies have shown that loess soils compacted with vibratory rollers to a dry soil density of 1.65 t/ m3 are practically non-subsident under dynamic loads up to P = 0.3 MPa, even with full water saturation. In our view, and this is confirmed by the studies carried out, the increase in seismic resistance of moistened loess soils when using vibration compaction is due to the following factors: the soil experiences dynamic effects even before the construction of the structure; an increase in density is achieved, which leads to an increase in the values of the friction angle and the connectivity of the soil; the magnitude of the critical acceleration of the soil increases. The method of vibration compaction using vibrating machines is the most effective for increasing the strength of bulk soils, when filling them in small layers. However, as our field studies have shown, vibration compaction can also be used for compaction of soil and undisturbed structure.

The method of compaction of soils using vibratory rollers is an effective and accelerated method of preparing the foundations of buildings on low-power loess subsidence soils. The normal operation of the erected buildings testifies to the reliability of the preparation of the foundations.

To achieve a given strength of the soil, it is necessary to take into account its certain humidity. This is necessary to ensure its proper strength, deformability within certain limits and workability, in relation to the sealing mechanisms available for construction.

When calculating the economic efficiency of the soil compaction method using vibratory rollers, options for preparing the bases should be considered. Ensuring the complete elimination of the subsidence properties of loess soils.

Among the methods of soil compaction that ensure the complete elimination of the subsidence properties of the loess thickness, the method of compaction of soils using vibratory rollers is reliable and economical. The cost of 1 m3 of compacted soil is 2-3 times cheaper compared to surface methods of compacting soils with heavy ramming.

The developed recommendations on vibration compaction of bulk soils around the foundation and foundations give a good result in the plan under consideration for buildings characterized by a load intensity up to P = 0.15-0.20 MPa.

In conclusion, it should be noted that in the conditions of Central Asia, in particular Uzbekistan, where additional deformations (seismic subsidence) may occur in the foundations and around the foundations of buildings and structures, the method of compaction of soils using vibratory rollers is the most reliable way to prepare the foundations of buildings and structures.

REFERENCES

1. Khakimov, G. A. "Changes in the Strength Characteristics of Glinistx Soils under the Influence of Dynamic Forces International Journal of Engineering and Advanced Technology, IJEAT." Exploring innovation (2020): 639-643.
2. Khakimov, Gayrat Akramovich. "The nature of the change in the connectivity of moistened loess soils during vibration." American Journal of Applied Science and Technology 2.06 (2022): 26-41.
3. Khakimov, G. A., and M. A. Muminov. "CONSTRUCTION OF BUILDINGS ON WEAK MOIST CLAY SOILS IN SEISMICALLY ACTIVE ZONES OF UZBEKISTAN." Web of Scientist: International Scientific Research Journal 3.12 (2022): 755-760
4. GMFN, Dos, Samiyeva Sh Kh, and Master MA Muminov. "DEFORMATION OF MOISTENED LOESS FOUNDATIONS OF BUILDINGS UNDER STATIC AND DYNAMIC LOADS." (2022).
5. Miralimov, Mirrakhim Mirmakhmutovich. "Principles of Regulation of Thermal Protection of Enclosing Structures and Their Impact on the Energy Efficiency Of Buildings." Design Engineering (2021): 496-510.
6. Хакимов, Ғайрат, et al. "ЭНЕРГИЯТЕЖАМКОР ВА ПАСТ ЭНЕРГИЯ ЭҲТИЁЖЛИ ЗАМОНАВИЙ БИНОЛАР ҚУРИЛИШИНИНГ ЖАҲОН АМАЛИЁТИ ВА УНДАН ЎЗБЕКИСТОН ШАРОИТИДА ФОЙДАЛАНИШ ИСТИҚБОЛЛАРИ." Talqin va tadqiqotlar 1.19 (2023).

7. Khakimov, Gayrat Akramovich. "CHANGES IN PLASTIC ZONES IN LESS BASES UNDER SEISMIC VIBRATIONS."
8. Khakimov.G.A. JabborovB.M. Designing and Construction of Buldings in Complex Ground Conditions of Central Asia. International Journal of Advanced Research in Science, Engineering and Technology, ISSN: 2350-0328, vol.6, Issue7, July 2019, page10266-10269.
9. Khakimov Gayrat Akramovich. (2023). CONSTRUCTION OF BUILDINGS AND STRUCTURES IN DIFFICULT GROUND CONDITIONS AND SEISMIC AREAS. INTERNATIONAL BULLETIN OF APPLIED SCIENCE AND TECHNOLOGY, 3(2), 203–209.
10. Khakimov Gayrat Akramovich. (2023). NEW GENERATION BUILDINGS THAT EFFECTIVELY USE ENERGY AND THEIR UZBEK EXPERIENCE. INTERNATIONAL BULLETIN OF ENGINEERING AND TECHNOLOGY, 3(2), 74–78.
11. Khakimov Gayrat Akramovich. (2023). CONSTRUCTION OF BUILDINGS AND STRUCTURES IN DIFFICULT GROUND CONDITIONS AND SEISMIC AREAS. INTERNATIONAL BULLETIN OF ENGINEERING AND TECHNOLOGY, 3(3), 74–80.
12. Khajiev, N. M. "CHANGE IN THE CONSISTENCY CHARACTERISTICS OF THE WETTED LUSSIC BASES (GRUNTS) OF BUILDINGS UNDER THE INFLUENCE OF SEISMIC FORCES." Академические исследования в современной науке 1.13 (2022): 261-267.
13. GMFN, Dos, Samiyeva Sh Kh, and Master MA Muminov. "DEFORMATION OF MOISTENED LOESS FOUNDATIONS OF BUILDINGS UNDER STATIC AND DYNAMIC LOADS." (2022).
14. Хасанов, Б. Б. "ПРОЧНОСТЬ, ПЛОТНОСТЬ, МОРОЗОСТОЙКОСТЬ И ДОЛГОВЕЧНОСТЬ, ГАЗОБЕТОННЫХ БЛОКОВ." RESEARCH AND EDUCATION 1.7 (2022): 68-73.
15. Makhmudovich, Makhmudov Said. "Research Of The Work Of The System" Base-Foundation With A Damping Layer-Building" On An Inhomogene Soil Base." Turkish Journal of Computer and Mathematics Education (TURCOMAT) 12.7 (2021): 2006-2015.
16. Rakhmankulovna, A. K. H., and M. S. Makhmudovich. "Innovative designs and technologies in foundation engineering and geotechnics." International Journal of Scientific and Technology Research 9.1 (2020): 3803-3807.
17. Machmudov, S. M., and Sh Kh Samieva. "QUANTITATIVE ASSESSMENT OF THE RELIABILITY OF THE SYSTEM" FOUNDATION-SEISMIC ISOLATION FOUNDATION-BUILDING"." Central Asian Journal of STEM 2.2 (2021): 445-452.
18. Махмудов, С. М., and Ш. Х. Самиева. "КОНСТРУКТИВНЫЕ РЕШЕНИЯ СЕЙСМОИЗОЛИРУЮЩИХ ФУНДАМЕНТОВ ЗДАНИЙ." НАУЧНЫЕ РЕВОЛЮЦИИ КАК КЛЮЧЕВОЙ ФАКТОР РАЗВИТИЯ НАУКИ И ТЕХНИКИ (2021): 36-38.
19. Махмудов, С. М., and Ш. Х. Самиева. "КОНСТРУКТИВНЫЕ РЕШЕНИЯ СЕЙСМОИЗОЛИРУЮЩИХ ФУНДАМЕНТОВ ЗДАНИЙ." НАУЧНЫЕ РЕВОЛЮЦИИ КАК КЛЮЧЕВОЙ ФАКТОР РАЗВИТИЯ НАУКИ И ТЕХНИКИ (2021): 36-38.