The American Journal of Engineering and Technology
ISSN 2689-0984 | Open Access

TYPE Original Research
PAGE NO. 170-177
DOI 10.37547/tajet/Volume07Issue10-21

Check for updates

The Problem Of Reducing The Degree Of Vibration Propagation From Railway Trains Into Buildings

Yuldashev Sharofitdin Sayfitdinovich

Doctor of technical sciences, professor, Namangan State Technical University, Uzbekistan

Abdujobborov Alisher Abdulkhay oglu

PhD student of Namangan State Technical University, Uzbekistan

OPEN ACCESS

SUBMITED 31 August 2025
ACCEPTED 22 September 2025
PUBLISHED 31 October 2025
VOLUME Vol.07 Issue 10 2025

CITATION

Yuldashev Sharofitdin Sayfitdinovich, & Abdujobborov Alisher Abdulkhay oglu. (2025). The Problem Of Reducing The Degree Of Vibration Propagation From Railway Trains Into Buildings. The American Journal of Engineering and Technology, 7(10), 170–177. https://doi.org/10.37547/tajet/Volume07Issue10-21

Abstract: The article studies the levels of wave propagation in a building caused by the movement of the Uzbekistan Talgo-250 train. The train moves at a speed of 30 m/s. The selected boundary area is the weight of the train cars, which is taken as a dynamic force. The finite element method is used to solve the problem. The article uses finite elements of the irregular tetrahedron shape.

Keywords: Railway, finite element method, soil, elasticity theory, elastic waves, vibration, boundary conditions, velocity, amplitude.

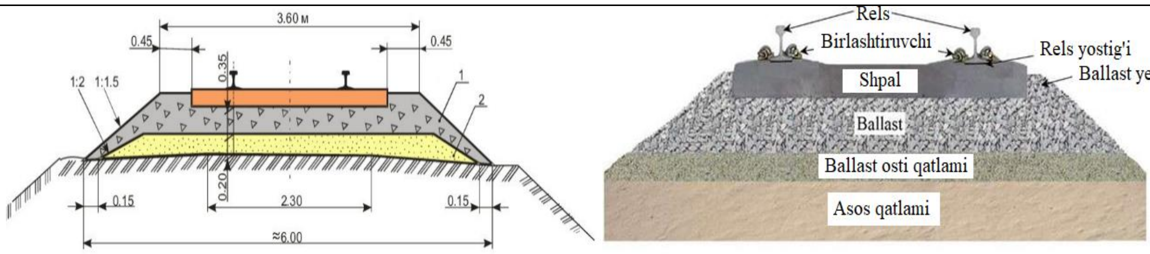
Introduction

In the case under consideration, the elastic wave vibration levels in two identically designed buildings due to the movement of a freight train in Uzbekistan are determined. The building is located 15 m from the center of the railway. A vibration barrier structure is used between the building and the vibration source. Rubber material was selected as the vibration barrier structure and it was designed to be 10 m from the edge of the railway. The vibration barrier structure is 1.0 m wide and 6.0 m deep. The effect of groundwater at a depth of 20 m from the surface of the earth was also taken into account in the case. The soil properties given in Tables 2 and 3 were selected as an example.

When forming the pavement for railway infrastructure, the drawing shown in Figure 1 was used, based on the standards for railway construction.

According to the drawing, a ballast sub-layer of 0.2 meters of sand and 0.4 meters of gravel is laid on top of the surface - the base layer, and sleepers and rails are planned on top of it.

Dynamic loads transmitted by train wheels are considered to affect the railway pavement. Taking into account the physical and mechanical properties of the material, we determine the wave propagation velocities along the x-axis of nodes taken in soils. In this problem, we replace the infinite half-space with a finite parallelepiped. At the same time, conditions are set on the faces of the parallelepiped, where the continuation of the medium is thrown.



a) Railway ballast design scheme

b) cross-sectional view of the railway ballast section

Figure 1. Design scheme and cross-section of the railway ballast section.

Figure 1. Design of railway and train masses as dynamic loads.

$$\left.\begin{aligned}\sigma_x &= a\rho V_p\dot{u}\\ \tau_{yz} &= b\rho V_s\dot{u}\\ \tau_{zy} &= b\rho V_s\dot{w}\end{aligned}\right\}\qquad \left.\begin{aligned}\sigma_y &= a\rho V_p\dot{v}\\ \tau_{xz} &= b\rho V_s\dot{w}\\ \tau_{zx} &= b\rho V_s\dot{u}\end{aligned}\right\}\qquad \left.\begin{aligned}\sigma_z &= a\rho V_p\dot{w}\\ \tau_{xy} &= b\rho V_s\dot{u}\\ \tau_{yx} &= b\rho V_s\dot{v}\end{aligned}\right\}\qquad (1)$$

The kinematic relationship can be formulated as follows:

$$\varepsilon = Lu \qquad (2)$$

L^T The differential operator defined as the transposition is

$$L^T = \begin{bmatrix} \frac{\partial}{\partial x} & 0 & 0 & \frac{\partial}{\partial y} & 0 & \frac{\partial}{\partial z} \\ 0 & \frac{\partial}{\partial y} & 0 & \frac{\partial}{\partial x} & \frac{\partial}{\partial z} & 0 \\ 0 & 0 & \frac{\partial}{\partial z} & 0 & \frac{\partial}{\partial y} & \frac{\partial}{\partial x} \end{bmatrix} \qquad (3)$$

To solve the problem, we use the finite element method. The limiting dynamic model of the problem solution space is shown in Figure 2.

The basic equation that relates the time-dependent displacement of a volume under dynamic loading is expressed as follows:

$$M\ddot{u} + C\dot{u} + Ku = F, \qquad (4)$$

where M is the mass matrix, u is the displacement vector, C is the damping matrix, which also takes into account the boundary conditions, K is the stiffness matrix, and F is the load vector. The compression u, velocity $\dot{u}$, and acceleration $\ddot{u}$ can change over time.

The theory is described here in terms of linear elasticity. However, in principle, all models can be used for dynamic analysis. The soil condition can be either drained or undrained. (The study sites may or may not have groundwater levels for reference.) In Plaxis 3D, you can solve problems related to the presence and absence of water.

The **M** matrix takes into account the mass of materials (soil + water + any structure).

In the numerical representation of dynamics, the formation of time integration is an important factor in the stability and accuracy of the computational process. The Newmark numerical integration scheme is used.

The properties of the soil and material are shown in Tables 1 and 2.

Two different types of soil were selected for this purpose. Their characteristics are listed in the table below.

Table 2

Soil type and characteristics	Clay [light brown, loess-like, large-pored, medium-hard, moist and low-moisture soils]
№	1
Type of model used	Mohr-Coulomb
Dry density - γ_{unsat} [kN/m^3]	16,9
Density when saturated with water - γ_{sat} [kN/m^3]	18,2
Deformation modulus - E_d [kN/m^2]	
- in natural humidity	7,5
- when saturated with water	4,5
Internal friction angle – ϕ [º]	25
Expansion angle – ψ [º]	2
Viscosity - c_{ref} [kN/m^2]	12
Elasticity modulus - E [kN/m^2]	200
Poisson's ratio - ν	0,3

The physical and mechanical properties of the materials used for the ballast layer soil and construction for the design of the railway line were adopted based on the values in Tables 2 and 3 above.

The building structure is brick, the foundation, roof and roof structure are made of reinforced concrete. The table below describes the characteristics of the materials used for the building.

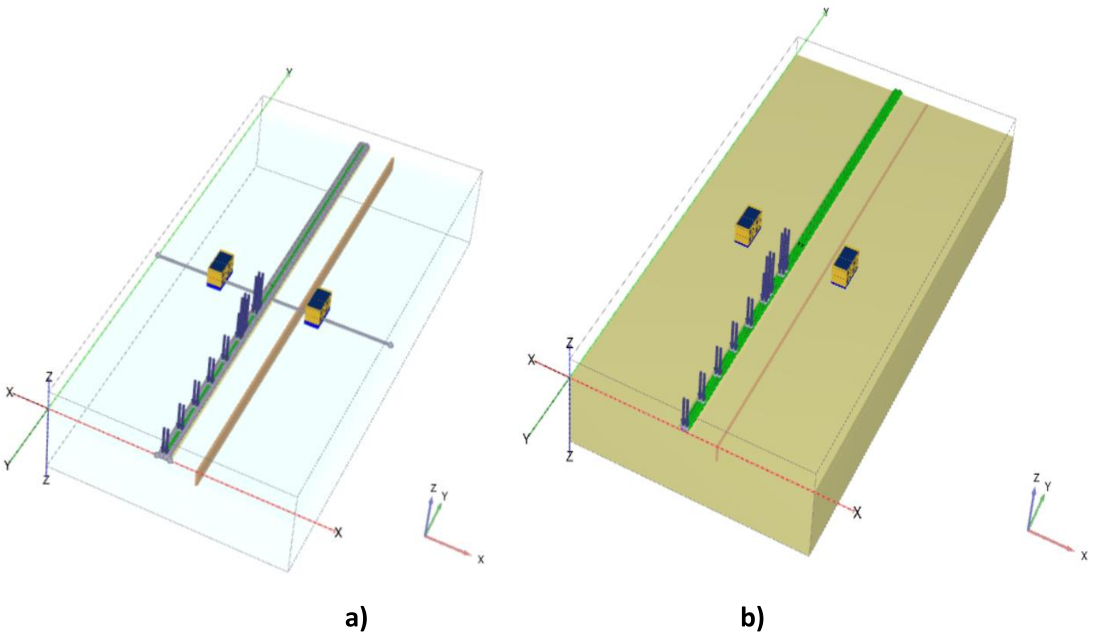
Table 3

Material name / Material properties	Foundation	Roofing and roofing	Brick walls
№	1	2	3
Type of model used	Elastic	Elastic	Elastic
Thickness - d [m]	0,4	0,2	0,38
Volumetric weight - γ [kN/m^3]	24,0	24,0	18,0
Elasticity modulus - E [kN/m^2]	$2,75*10^6$	$3,06*10^6$	$1,7*10^6$
Poisson's ratio - ν	0,2	0,2	0,2

Table 4 below describes the properties of the materials used for the construction of the vibrating barrier.

Table 4

Material name / Material properties	Rubber
№	1
Type of model used	Elastic
Thickness - d [m]	1,0
Volumetric weight - γ [kN/m^3]	15,0
Elasticity modulus - E [kN/m^2]	$8 \cdot 10^6$
Poisson's ratio - ν	0,45



Figures 5 (a and b). Finite element model of the problem.

a) a vibrating barrier structure was used b) a vibrating barrier structure was not used.

Results

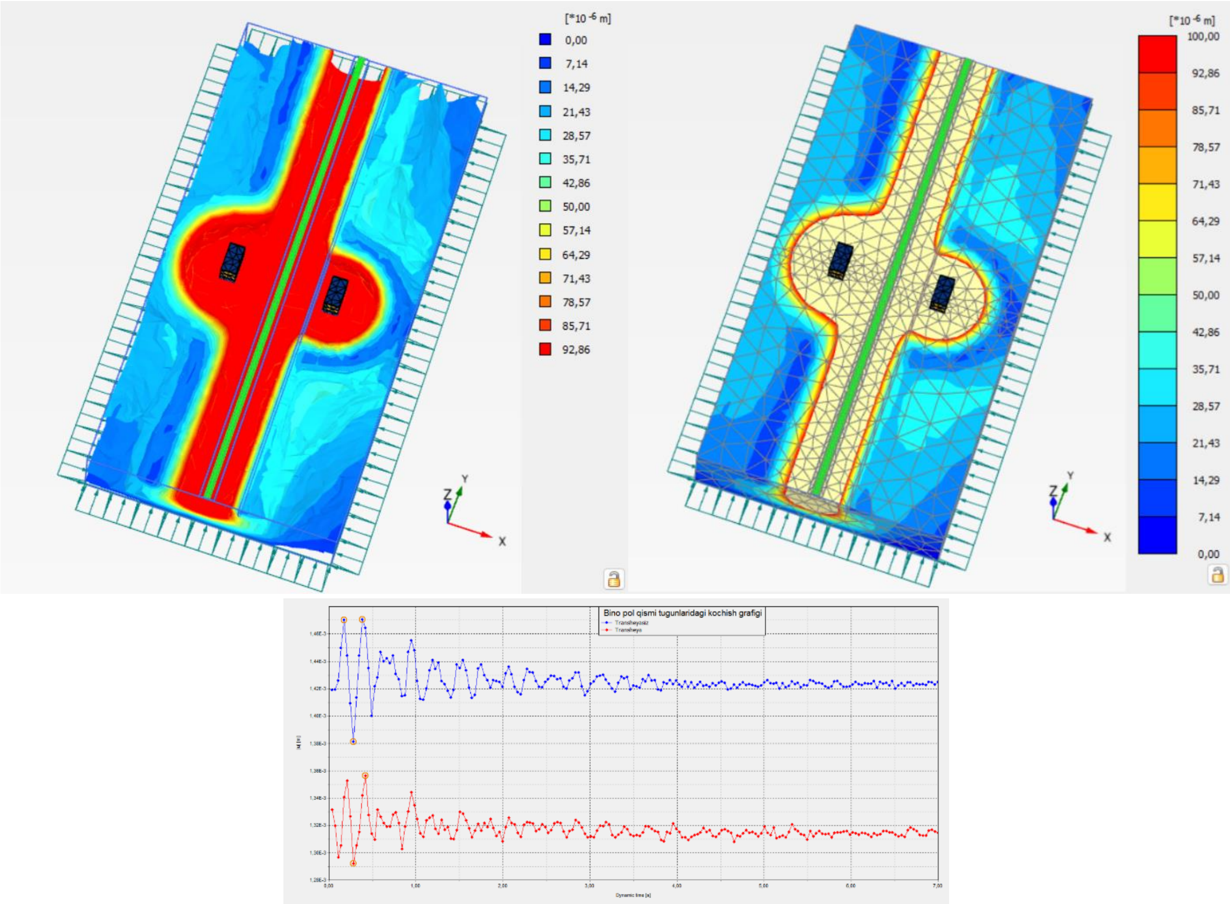


Figure 6. Displacement at nodes resulting from railway traffic when a vibration barrier structure is used.

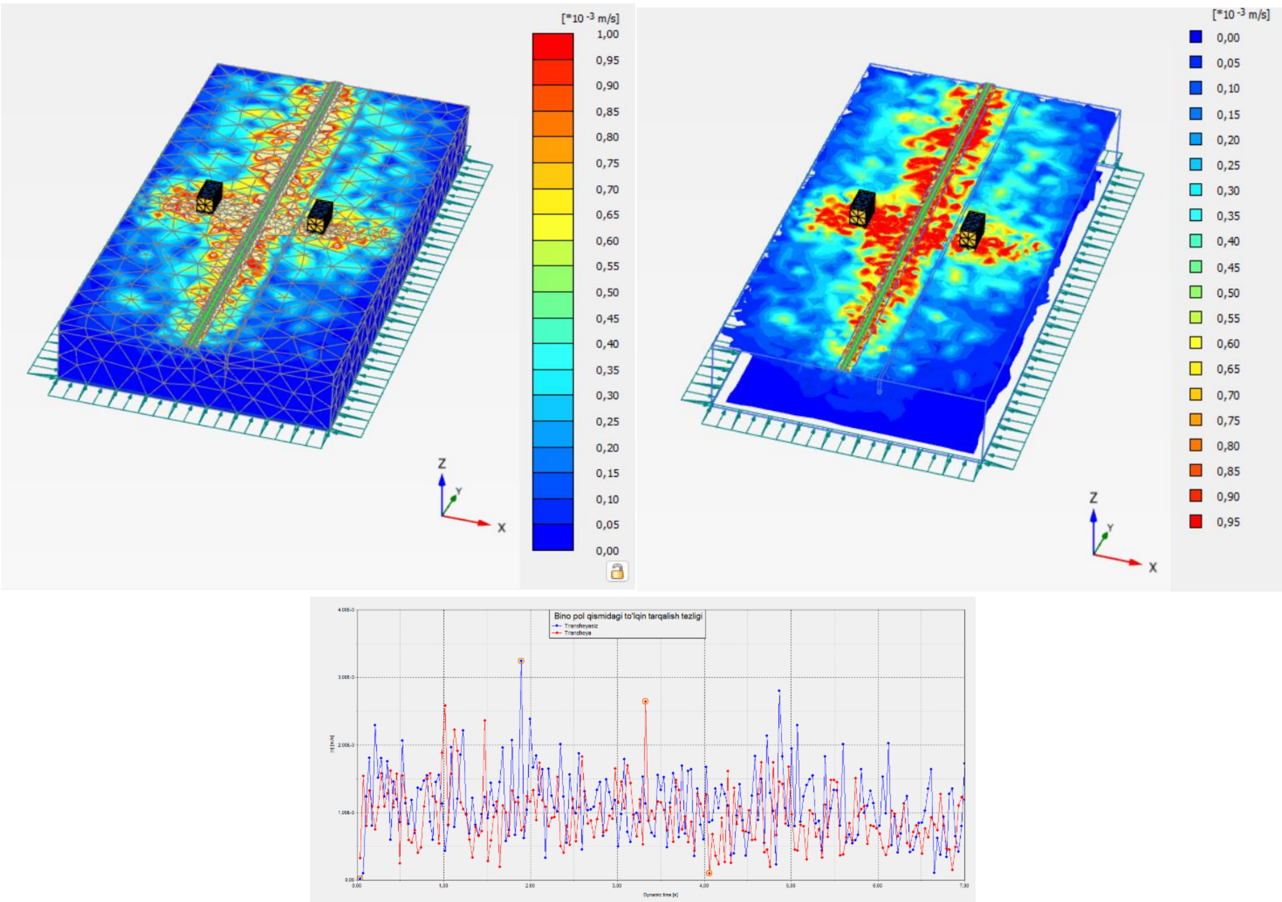


Figure 7. Wave velocity graphs for cases with and without a vibration barrier structure at a distance of 10 m from the center of the railway.

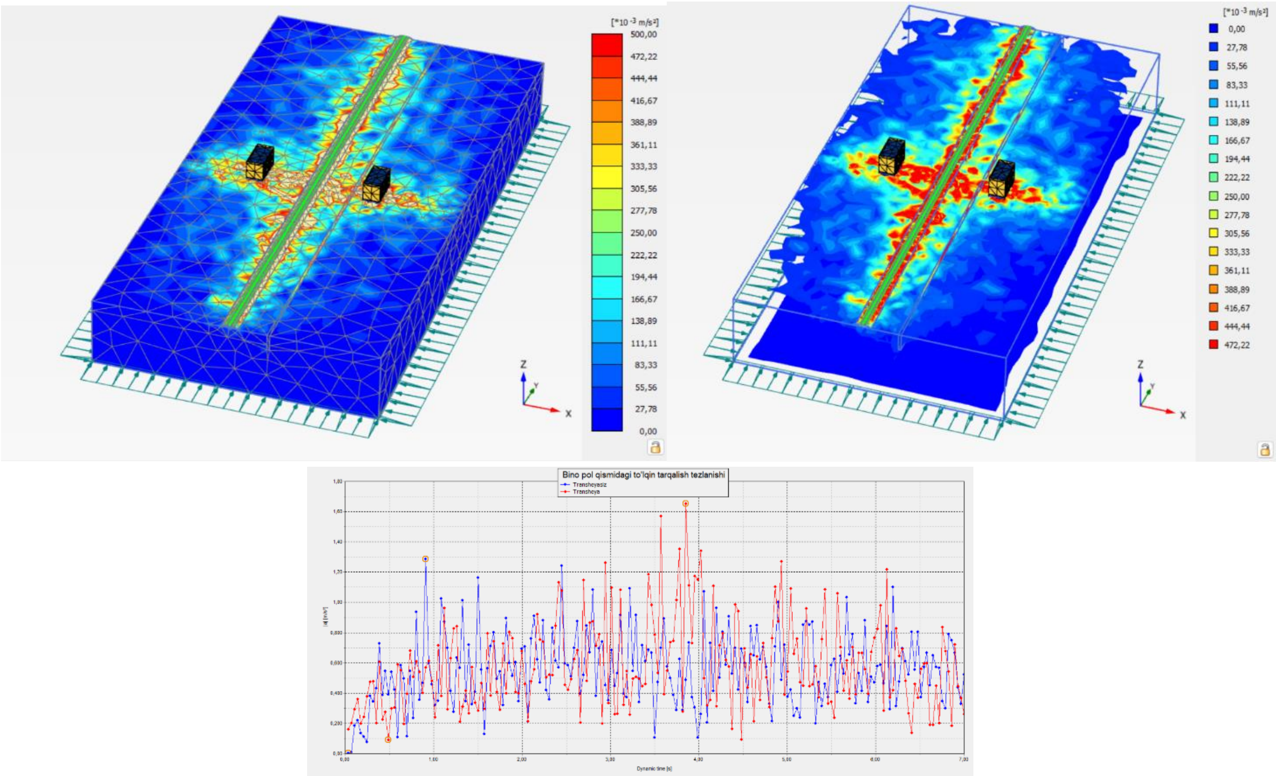


Figure 8. Wave acceleration graphs for cases with and without a vibration barrier structure at a distance of 10 m from the center of the railway.

Table 9

№		**Wave propagation speed lvl, [mm/s]**			**Acceleration of wave propagation lvl, [mm/s²]**			**Migration at nodes lul. [mm]**		
1		Trenchless	Trench	*The difference*	Trenchless	Trench	*The difference*	Trenchless	Trench	*The difference*
2	Max	3,24	2,64	*36,4%*	16,61	12,9	*22,33%*	1,47	1,36	*7,74%*
3	Min	1,56	0,990	*18,5%*	9,01	1,21	*86,57%*	1,38	1,29	*6,45%*

The results of an experimental study of the propagation of vibrations through the ground generated by the movement of the Talgo-250 passenger train moving in the territory of Uzbekistan are presented in Table 9. During the study, cases where a trench, that is, a rubber-based barrier structure, was used as a factor affecting the propagation of vibration waves to buildings were analyzed.

- According to the measurement results, the following significant reductions were observed in the presence of the trench:
- • The migration rate is 7.74%;
- • Velocity (vibration propagation speed) up to 36.4%;
- • Acceleration decreased by 22.33%.

These results confirm that rubber-rubber materials acting as trenches effectively absorb dynamic loads, in particular seismic vibrations, transmitted through the ground.

The study concludes that the placement of vibration isolation structures between the building and the vibration source (railway) can be considered an effective engineering solution to reduce harmful vibrations transmitted from railway transport. This approach not only ensures the structural stability of structures, but also serves to protect the living conditions and health of the population.

References

1. Ilyichev V.A., Matkarimov P.J., Yuldashev Sh.S. Passiv tebranish izolyatsiyasi bilan bir jinsli bo’lmagan tekis tizimning majburiy tebranishlarini tekshirish // Poydevorlar, poydevorlar va tuproq mexanikasi. - 1999. - yo’q. 2.

2. Tompson JJ, Jiang J, K MGR, Hussein M.F.M., Dijkmans A., Coulier P., Degrand G., Lombert G. Zaminni mustahkamlash bilan temir yo’ldan kelib chiqadigan tebranishlarni kamaytirish. Tuproq dinamikasi va seysmik qidiruv, 2015; 79:89-103.

3. Tsitovich N.A. Tuproq mexanikasi [Matn] / N. A., Tsytovich. - M.: Vyssh.shk., 1983. - 288 b.

4. Ter-Martirosyan Z.G. Tuproq mexanikasi [Matn] / Z.G.Ter-Martirosyan. – M.: DIA nashriyoti, 2005. – 488 b.

5. Yo’ldoshev S. _ S ., Boytemirov M. _ Temir yo’lning joylashuv darajasining poezdlar harakatidan to’lqinlarning tarqalish darajasiga ta’siri // Nazariy va amaliy. fan . – 2020. – yo‘q. 5. - S. 140-143.

6. Ilyichev V.A., Yuldashev Sh.S., Saidov S.M. Temir yo’lning joylashishiga qarab poezdlarning o’tishi paytida tebranishning tarqalishini o’rganish // Poydevorlar, poydevorlar va tuproq mexanikasi. - 1999. - yo’q. 2. - S. 12-13.

7. Yo’ldoshev Sh.S. va boshqalar Temir yo’l balandligining poezdlar harakatidan kelib chiqadigan er tebranishlari darajasiga ta’siri // Hozirgi zamonning ilmiy bilimlari. – 2018. – yo‘q. 10. - S. 55-57.

8. Il’ichev VA, Yo’ldoshev S.S., Saidov SM. Poezdlardan tebranishning yo’l holatiga nisbatan tarqalishi //Tuproq mexanikasi va poydevor muhandisligi. - 1999. - T. 36. - Yo’q. 2. - S. 55-56.

9. Yuldashev Sh.S., Saidov S.M., Nabiev M.Ya. Temir yo’l poezdlari harakatidan kelib chiqadigan tuproqlarda tebranishlarning tarqalishi // Yosh olim. – 2015. – yo‘q. 11. - S. 481-483.

10. Ilyichev V.A., Yuldashev Sh.S. Temir yo’l poezdlari harakatidan yer tebranishlarini bashorat qilish usuli // Seysmik chidamli qurilish. Qurilish xavfsizligi. - 2006. - yo’q. 1. - S. 3-8.

11. Yuldashev Sh.S., Abdujobborov.A.A. Tez yurar poezd harakati natijasida hosil bo’ladigan tebranishlarni ballast qismini ko’tarish hamda ballast qatlami gruntini o’zgartirish orqali // NamDU ilmiy axborotnomasi, №10-son, 2024-yil. 9-14 b.

12. Boytemirov.M.B., Abdujobborov.A.A. Temir yo‘l poyezdlari harakatidan hosil bo‘ladigan tebranishlarning masofa bo‘yicha tarqalishi // Qurilish va ta’lim ilmiy jurnali, maxsus son №2-son, 2024-yil. 16-22 b.

13. Yuldashev Sh.S., Abdujobborov.A.A. Temir yo‘l izini barxan qumlari joylashgan hududda ko‘tarma qilib loyihalash hamda transheya va transheyasiz holatda tez yurar poyezd harakatidan hosil bo‘ladigan tebranishlarni tekshirish masalasi // NamDU ilmiy axborotnomasi, №2-son, 2025-yil. 4-9 b.

14. Yuldashev Sh.S., Abdujobborov.A.A. Tez yurar poezd harakati natijasida hosil bo‘ladigan tebranishlarni ballast qismini ko‘tarish hamda asos qatlami gruntini o‘zgartirish orqali tekshirish masalasi // «Qurilishda innovatsiyalar, binolar va inshootlarning seysmik xavfsizligi» Xalqaro miqyosidagi ilmiy va ilmiy-texnik konferensiya. – Namangan. 14.12.2023 yil. 276-282-b.

15. Yuldashev Sh.S., Abdujobborov.A.A. Temir yo‘l izini barxan qumlari joylashgan hududda 2 xil ko‘tarma qilib loyihalash orqali tez yurar poyezd harakati natijasida hosil bo„ladigan tebranishlarni tekshirish masalasi // «Qurilishda innovatsiyalar, binolar va inshootlarning seysmik xavfsizligi» Xalqaro miqyosidagi ilmiy va ilmiy-texnik konferensiya. – Namangan. 27-28.11.2024 yil. 129-133-b.

16. Boytemirov.M.B., Abdujobborov.A.A., Jo‘raboyev.M.M. Tez yurar poyezdning turli xil tezliklarda harakatlanishidan hosil bo’ladigan tebranishlarni tekshirish masalasi // “Xalqaro tajriba: oliy ta’limni transformatsiya sharoitida zamonaviy muhandislik yo‘nalishida intellektual qobiliyatli kadrlar tayyorlash istiqbollari” Xalqaro ilmiy konferensiya. Namangan. 29-30 aprel, 2025 yil.

17. Yuldashev Sh.S., Abdujobborov.A.A. Tezyurar poyezd harakatidan hosil bo‘ladigan tebranishlarni ikki xil gruntda tarqalish masalasi // “Xalqaro tajriba: oliy ta’limni transformatsiya sharoitida zamonaviy muhandislik yo‘nalishida intellektual qobiliyatli kadrlar tayyorlash istiqbollari” Xalqaro ilmiy konferensiya. Namangan. 29-30 aprel, 2025 yil.

18. Yuldashev Sh.S., Abdujobborov.A.A. Temir yo‘l poyezdlari harakatidan hosil bo‘lgan tebranishlarni binolarga tarqalish darajasini aniqlash // NamDTU “Arxitektura, qurilish va muhandislik sohalarida zamonaviy qurilish materiallari va texnologiyalari”

mavzusidagi xalqaro ilmiy va ilmiy-texnik konferensiya Namangan. 16-17-may, 2025-yil.