ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Казахский национальный исследовательский технический университет им. К. И. Сатпаева

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Kazakh national research technical university named after K. I. Satpayev

SERIES
OF GEOLOGY AND TECHNICAL SCIENCES

6 (438)

NOVEMBER – DECEMBER 2019

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

«ҚР ҰҒА Хабарлары. Геология мен техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 30.04.2010 ж. берілген **№10892-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,
http://www.geolog-technical.kz/index.php/en/

Редакцияның Қазақстан, 050010, Алматы қ., Қабанбай батыра көш., 69а.
мекенжайы: Қ. И. Сәтбаев атындағы геология ғылымдар институты, 334 бөлме. Тел.: 291-59-38.

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан (г. Алматы)

Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№10892-Ж,** выданное 30.04.2010 г.

Периодичность: 6 раз в год
Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел.: 272-13-19, 272-13-18, http://nauka-nanrk.kz /geology-technical.kz

---

Адрес редакции: Казахстан, 050010, г. Алматы, ул. Кабанбай батыра, 69а.
Институт геологических наук им. К. И. Сатпаева, комната 334. Тел.: 291-59-38.

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 10892-Ж, issued 30.04.2010

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://nauka-nanrk.kz/geology-technical.kz

Editorial address: Institute of Geological Sciences named after K.I. Satpayev
69a, Kabanbai batyr str., of. 334, Almaty, 050010, Kazakhstan, tel.: 291-59-38.

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 6, Number 438 (2019), 22 – 35 **https://doi.org/10.32014/2019.2518-170X.152**

UDC624.138
МРНТИ 55.53.13

M. V. Doudkin[1], B. Apshikur[1], A. I. Kim[1],
T. T. Ipalakov[1], E. A. Asangaliyev[1], M. Mlynczak[2]

[1]D. Serikbayev East Kazakhstan state technical university, Ust-Kamenogorsk, Kazakhstan,
[2]Wroclaw University of Science and Technology, Poland.
E-mail: doudkin@mail.ru, bapshikur@ektu.kz, k.a.i.90@mail.ru,
tipalakov@ektu.kz, elibek60@mail.ru, mlymar@gmail.com

DEVELOPMENT OF AN INSTALLATION FOR SHEAR GROUND TESTING IN THE RAILWAY TRACK CONSTRUCTION

Abstract. The article presents an apparatus for testing ground shear to determine reliable baseline data taking into account the influence of vibrodynamic and pulsating loads on the strength and deformation parameters of clay grounds of various types with the possibility of modeling train load and train traffic.

Key words: ground, embankment, railway, roadbed, shear.

Introduction. The grounds, from which the railway roadbed is built, are distinguished by a great variety of physical and mechanical properties. The works of a number of well-known domestic and foreign specialists are devoted to the improvement of the construction of the railroad roadbed [1-8]. However, methods for determining the physical-mechanical properties of ground, taking into account vibrodynamic and pulsating loads, modeling, calculation and arrangement of two-layered and multilayer railway scraps from dissimilar grounds have not been sufficiently studied until nowadays.In this connection, in the present paper have performed:

- investigation of the vibrodynamic loading influence on the strength and deformation parameters of clay grounds of various types;
- identification of correlation dependencies between the strength and deformability parameters for the conditions of static, vibrodynamic and pulsating loads;
- possibility justification of the practical results use of the work in calculating the stress-strain state of the railways roadbed embankments, for carrying out experimental studies the author used a modified version of the single-plane cutter VSV-25 of the Hydroproject design, the scheme is shown in figure 1, and the general view is shown in figure 2 [9, 10].

The result of the conducted studies was the improvement of the installation for shear ground testing in order to determine reliable initial data, taking into account the influence of vibrodynamic and pulsating loads on the strength and deformation parameters of clay grounds of various types with the ability to simulate the train load and the intensity of train traffic;

A great contribution to the study of the stress-strain state under the train load, using detailed virtual prototypes of railroad embankments, as well as the development and improvement of instruments for ground testing, were made by professors [5-8].

Improvement of the installation for ground testing on shear in order to determine reliable initial data, taking into account the influence of vibrodynamic and pulsating loads on the strength and deformation parameters of clay grounds of various types. Unlike previously known, the device provides a more even distribution of stresses acting in the cut plane due to the symmetrical action of normal N and shearing forces T. An increase in the thickness of the device cages walls made it possible to

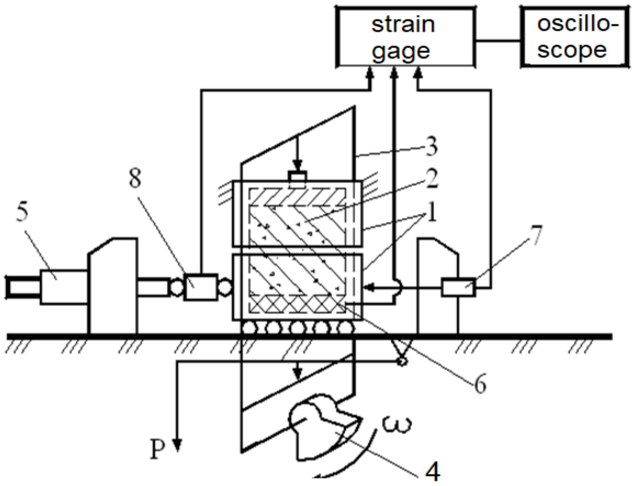

Figure 1 – Schematic diagram of the shifting device:
1 - holders of the shifting device; 2 - ground sample; 3 - loading frame; 4 - eccentric; 5 - the electric motor with a reducer; 6 - strain gauge of vertical load; 7 - strain gauge for moving the lower cage; 8 - strain gauge of horizontal force

Figure 2 –
General view of the shifting device

Figure 3 – General view of the rotational vibrator

achieve a value of the relative shear strain of the sample of 27%. To create vibrodynamic loading on the ground sample, an eccentric rotational vibrator with a DC motor drive PJK-25/3 was specially designed. The general view of the rotational vibrator is shown in figure 3. The change in the location of the eccentrics on the drive shaft makes it possible to vary the amplitude of the pulsating load. The operation of the instrument is organized in the kinematic mode (controlled deformation mode) with the possibility of monitoring at any instant of time both tangential stresses and shear strains. The shear rate can vary from 0.5 to 0.01 mm / min. The change in the shear rate is regulated by a change in the current strength of the BCA-5K power supply. The progressive motion of the lower movable holder of the device is created by the reduction gearbox MPK-13I-5 through the spindle. The general drive of the shearing system is carried out by the D-10ARU direct current motor. The general view of the working table of the device is shown in figure 4. For vibrodynamiceffects, the oscillation frequency is regulated by the laboratory automatic transformer "LATR". The value of the oscillation frequency is determined by the tachometer. The tachometer drive is carried out through the cable of the speedometer of the GAZ-53 car, connected to the driven shaft of the rotary vibrator. The device design allows creating a vibration frequency in the range from 0 to 30 Hz.

The device serves the control and measuring equipment (CME), which serves to monitor and measure the following values: the vertical load $N \pm \Delta N$ in the case of both static and vibrodynamic effects; horizontal shearing force T; moving the clips of the device [10-13].

Metrological support of experimental research is determined by the following requirements for the installation and accuracy of measurement of the main recorded values [9, 10]:

- to achieve the maximum homogeneity of the ground stress state sample in the instrument and the voltage determination accuracy in the conditions of static, vibrodynamic and pulsating loads (figures 1, 2);
- shift the movable holder of the device with a given constant speed of movement;
- to ensure the accuracy of measuring the horizontal displacement U and the force T with continuously monitoring the measuring devices;
- in the case of vibrodynamic loading, ensure the accuracy of measuring the normal pressure P and its amplitude variation ΔP; provide the possibility of their simultaneous registration on the oscilloscope tape at any time.

The uniformity of the stress-strain state of the samples is the main determining factor in the suitability of devices for use in scientific research. Since the uniformity of the stressed state is practically difficult to determine, it is usually judged indirectly by the degree of homogeneity of the deformed state of the material being studied.

In the device used, the normal sealing stresses on the structural cut plane are transmitted using a lever system of vertical force of the single-plane cutoff device GGP-30 of the design of N.N. Maslov - Yu.Yu. Lurie [5, 6, 13].

In this design, the vertical load created by the sliding sector lever (figure 2) is transferred to the sample through the frame and the upper hole die (figure 4). The frame has a rocker connected to the rods. In the center of the upper rocker arm there is a screw that adjusts the position of the die. Two other screws on this rocker are fixed with a stamp and a set of setscrews.

In the center of the lower rocker there is also a screw, which adjusts the position of the frame in the vertical direction. The screw is connected to the small arm of the creep lever via a cable through the end connecting plug. Its position is regulated by the handwheel. At the ends of the lever axis, sliders are placed, which are located between the slats of vertical racks attached to the bottom of the work table panel. The lower panel supports the lever, and the top panel serves as a fulcrum for it. To reduce friction between the upper bar and the sliders, there are flat ball bearings. The ratio of the arms of the lever of vertical force is 1:10. the lever is counterbalanced by the counterweight, and the goods are stacked on the pallet (figure 2), suspended from the draft.

The above-described design of the vertical loading system ensures the uniformity of the normal pressures transfer to the ground sample and thereby causes the uniformity of the deformed ground state in the cut plane.

The movement speed of the lower movable holder of the device is determined by the operation of the electric motor with a reducer (figure 4) and a screw jack that converts the rotation into a linear slide motion with the spindle. The device uses a reversible direct-current electric motor of the D-10ARU type

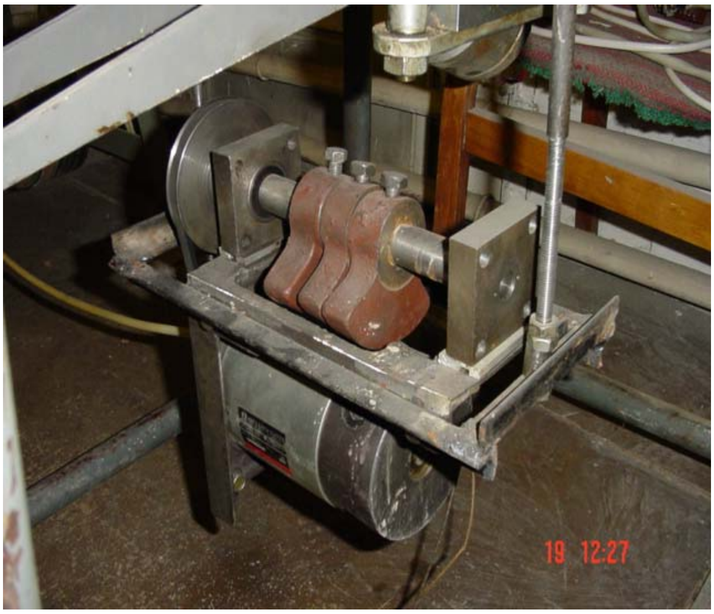

Figure 4 – General view of the device working table

with a gearbox of the MPK-13I-5 type, the supply voltage is from 0 to 30 V. The speed is regulated by changing the voltage and current strength of the BCA-5K power supply. The usual instability of the DC motor does not affect the speed of the clip due to the large gear ratio (more than 216000) of the reducing gearbox MPK-13I-5.

The movement of the lower movable holder of the cut-off device was determined by the indicator of the hour type ICh-25, with a scale division of the main scale of 0.01 mm and an allowable measurement error of 0.022 mm. In addition, through each millimeter, the movement was registered on the tape of the light-beam oscillograph H071.6M.

The change in the horizontal force T was fixed according to the indicators of the clock type ICh-10 dynamometers of compression. The reading on the dynamometer indicators was also taken in every movement millimeter of the movable device holder.

The measuring accuracy of the horizontal force T is determined by the dynamometers accuracy DOSM-3-1,0 No. 791, DOSM-3-1,0 №595 and DOSM-3-0,1 No. 404, which operate on the force determining principle from the deformation value of a special elastic shaped elastic element. The scale division for the dynamometer DOSM-3-1 №791 is 0.157% of the largest measurement limit, for dynamometers DOSM-3-1 №595 and DOSM-3-0,1 №404 - 0,150 and 0,066% respectively. The difference in the mean values for the dynamometer readings from the measured value at triple loading to the maximum limit value and unloading was no more than 0.5%. Graphs of dynamometers calibration are shown in figure 5.

To measure the value of the pulsating normal pressure $P \pm \Delta P$, we used the M-70 mesdose of D.S. Baranova design, developed in CSRIBC, mounted in the lower part of the movable holder of the device. The principle of the mesdose work is based on a change in the resistance of a working strain gage connected to a compensating half-bridge circuit. When the strain gauge bends, the resistance of the strain-gauge half-bridge changes. The electrical signal of the strain gage is amplified by the "Topaz-3-01" strain-gage amplifier and fed to the light-beam oscillograph H071.6M, which converts the electrical signal into a light beam leaving a trace on the oscilloscope tape. The general view of the Topaz-3-01 strain gage and the H071.6M oscilloscope is shown in figure 6.

The measurements accuracy estimation was carried out in accordance with the requirements for the form of measurement estimates presentation of the error stated in the scientific literature [7, 8] and normative materials [14].

The absolute measurement error δ was determined by the ratio $\delta = x/\Delta x$. The total measurement error $\delta_\Sigma$was determined from the number *n* measurements (or experiments) performed, n = 3÷5 [8].

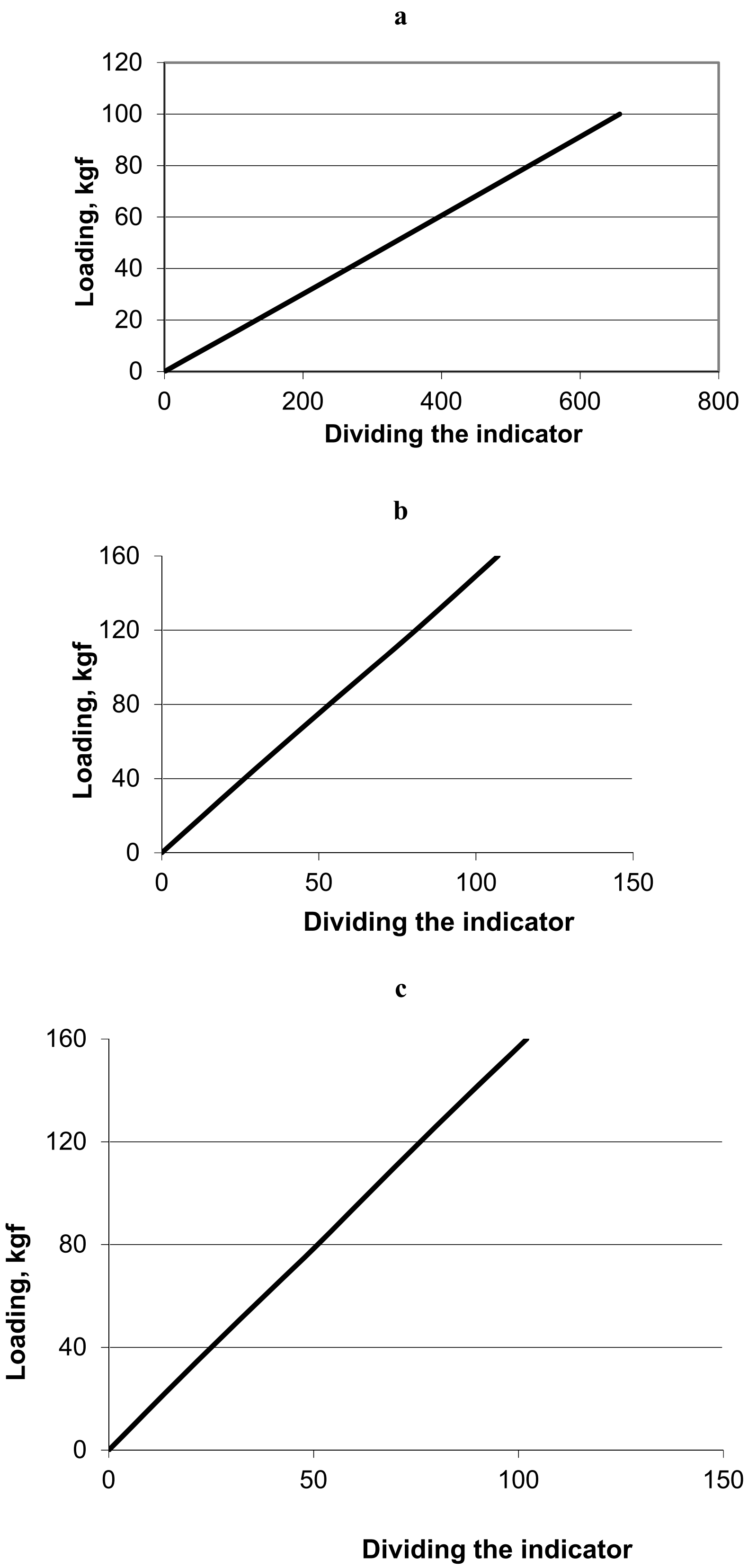

Figure 5 – Calibration curves of working dynamometers:
a - dynamometer №404; b - dynamometer №545; c - dynamometer №791

Figure 6 – Topaz-3-01 strain gage (1) and oscillograph H071.6M (2)

The calculations performed in this way showed that the accuracy of measuring the main fixed values varies between 4-6.5%. This result does not exceed the accuracy of measurements for such studies - 7% [7].

The measurement of the pressure P±ΔP produced in a ground sample with the application of a vibrodynamic load N±ΔN is carried out by mesdose and the corresponding equipment according to the following scheme: mesdose - amplifier - converter "Topaz-3-01" - oscilloscope H071.6M. The recording was made every moving millimeter of the movable device holder for the subsequent decoding of the oscillogram and the refinement of the P±ΔP value during the cameral work. The instrumentation calibration is carried out under static loading conditions. The calibration results of the oscilloscope light beam deviation are shown in figure 7. The accuracy of the calibration performed is determined by the

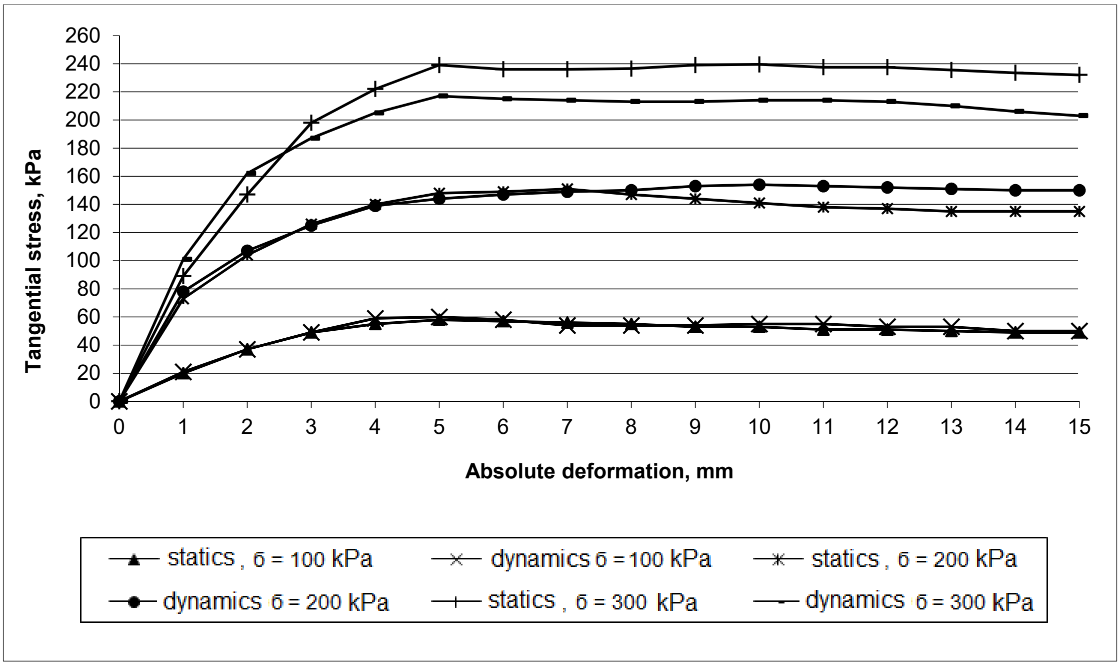

Figure 7 – Graph of the relationship between absolute strain and shear stress (ground number 1)

accuracy of the used model dynamometer DOSM-3-1, accuracy class -I. Deviations of the conventional zero of the light beam of the oscillograph H071.6M with triple loading and triple unloading were not recorded.

In the working room where all experimental studies were carried out, a practically constant temperature of 20±0,1^{0}C and a humidity of 75% was maintained, so the temperature correction was not taken into account when processing the data of the control equipment, since it is negligible.

Results of shear tests. Shift characteristics of clay grounds. Figure 7 presents the shear resistance results of the plastic sandy loam of the broken addition (ground No. 1) for static and vibrodynamic loading conditions. The results are presented in the form of relationship graphs between the tangential stress and the absolute deformation of the sample (moving the movable carriage of the shear device).

On the basis of figure 7, shear diagrams are constructed for static and vibrodynamic tests for peak and residual strength of the ground. To construct a shear diagram corresponding to the peak strength, the limiting values of shear stress at normal pressures of 100, 200 and 300 kPa were used.

When creating a diagram characterizing the residual strength, the tangential stresses corresponding to the absolute deformation of the sample equal to 15 mm at the same normal pressures were adopted. The shift diagrams are shown in figure 8.

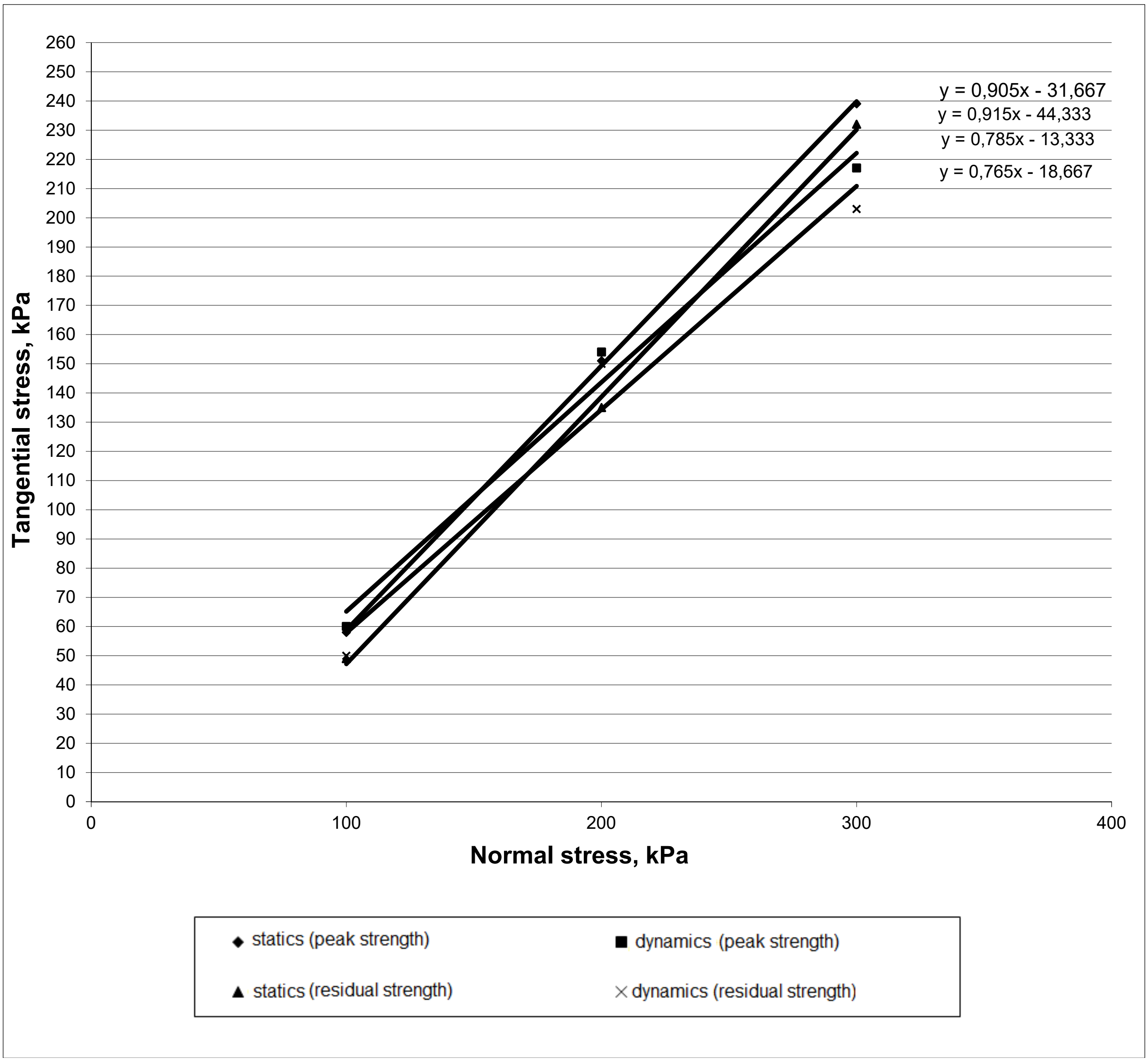

Figure 8 – Shear diagram (ground number 1)

Parameter φ (angle of internal friction) for peak strength in static tests is $43^0 12'$, for vibrodynamic $38^0 8'$; for the residual strength $\varphi_{ст}=42^0 30'$, $\varphi_{din}=37^0 24'$. There was no significant difference between the values of parameter φ for peak and residual strength. In the case of static displacement, the difference is 1.62%, vibrodynamic - 1.91%.

The dynamic effect leads to a change in the value of the strength parameter φ by 11.74% for peak strength and by 12% for the residual value.

It should be noted that the sealing load greatly influences the shear resistance under vibration conditions. At a normal pressure of 100 kPa, the static shear resistance is practically equal to the vibro-dynamic resistance. At a pressure of 200 kPa, vibrodynamic action caused an increase in shear resistance at a strain greater than 7 mm.

The maximum value of the tangential stress for the static conditions is realized with a deformation of 7 mm, for the conditions of vibrodynamics - with a deformation of 10 mm. At a pressure of 300 kPa, the ultimate shear resistance for static and vibrodynamic effects is achieved with an absolute deformation of the sample of 5 mm, but vibration causes a change in shear resistance, both for peak and residual strength.

Figure 9 shows graphs of resistance to sandy loam shear taken from the body of the mound on PC 40485 in Burundai from a depth of 1.5 m (ground number 2). Moving the carriage of the shear device from 0 to 15 mm corresponds to absolute deformation of the specimen at the initial shear, from 15 to 30 mm - with a second shear. The diagrams of ground displacement No.2 are shown in figure. 10. The following strength parameters for ground No. 2 are established in the shear diagrams: parameter φ for peak strength in static tests was - $\varphi_{st}^{peak}=43^0 42'$, for residual $\varphi_{st}^{res}=42^0 36'$.

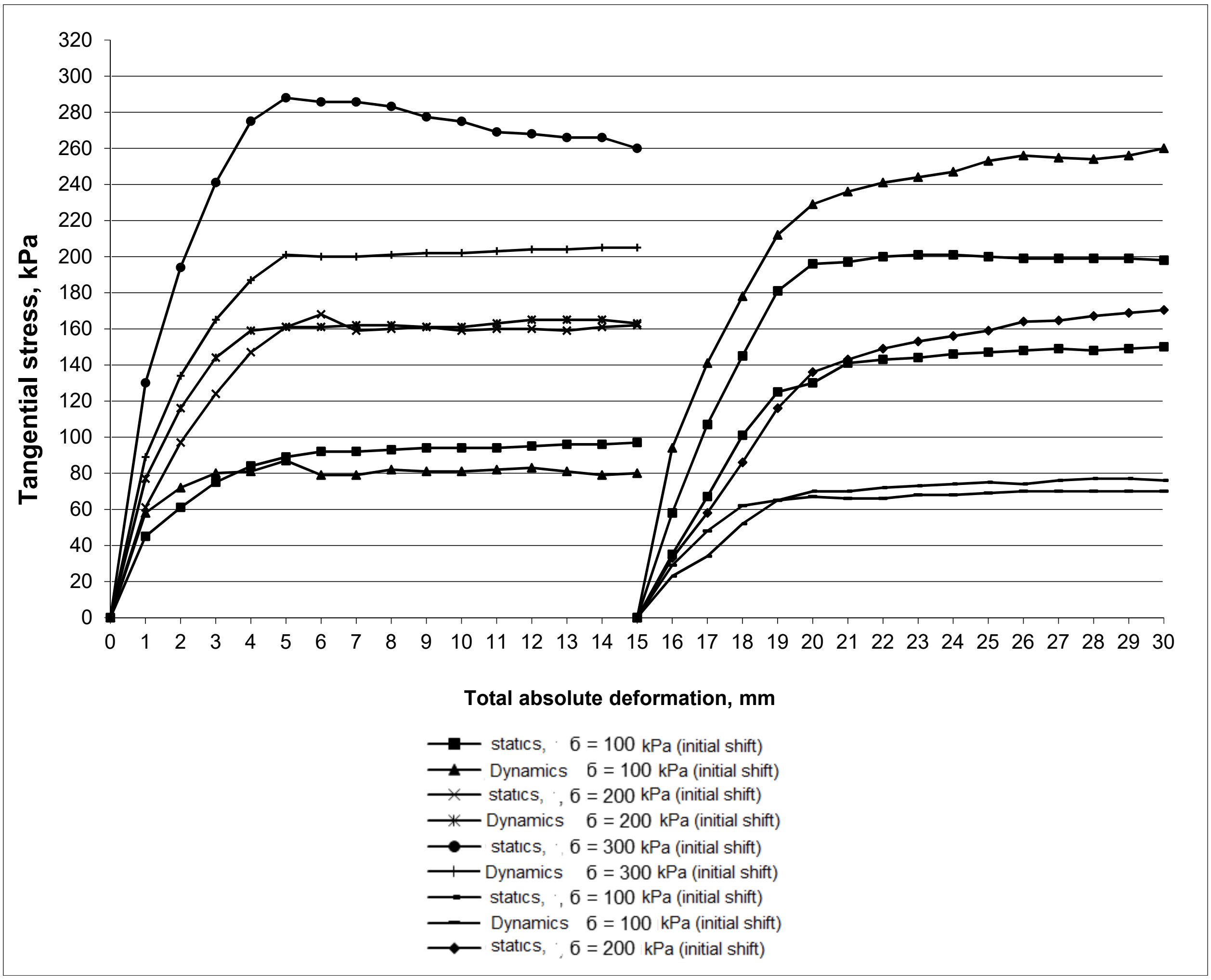

Figure 9 – Graph of the relationship between absolute strain and shearing stress (ground number 2)

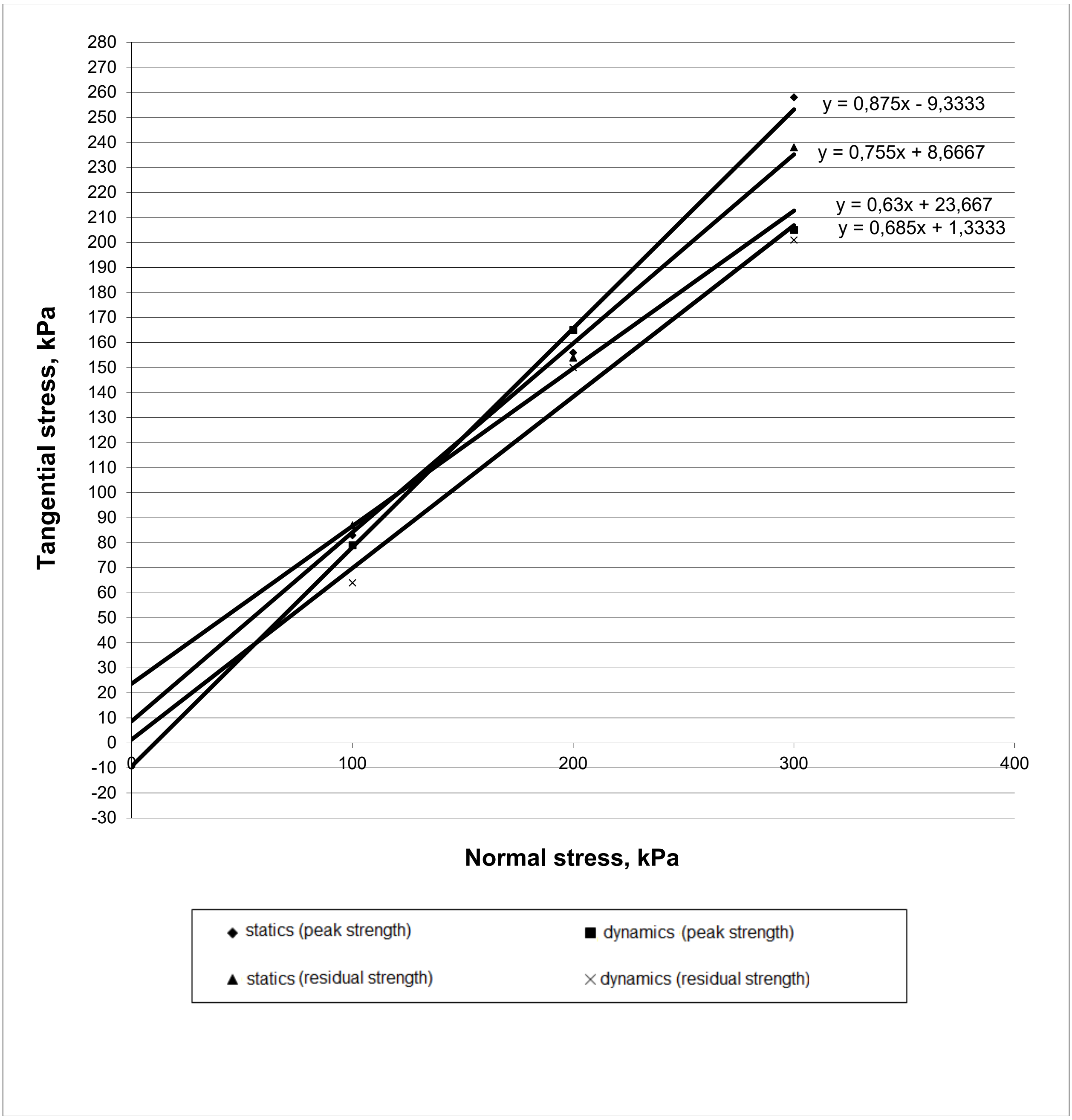

Figure 10 – Shear diagram (ground number 2)

In vibrodynamical tests, the angle of internal friction in determining the peak strength was φ_{din}^{peak} =29⁰42′, the specific adhesion C_{din}^{peak} = 35.7 kPa. Parameters of residual strength in vibrodynamics were respectively - φ_{din}^{res} =$32^0$36′, C_{din}^{res} = 11.3 kPa.

In the case of static the parameter φ for residual strength decreased by 2.5% with respect to the peak strength, the coupling C, as well as for the ground No. 1, on the basis of the straight lines equation has negative values, both for the peak strength diagram and for the residual diagram strength, which has no physical meaning.

Under vibrodynamic conditions, the parameter increases for residual strength by 8.9% relative to the peak strength and the parameter C decreases by 68.3% (the adhesion decreased by 3.2 times).

Vibrodynamic action reduced the value of the internal friction angle φ by 32% (by 14^0) for peak strength and by 23.5% for the residual (by 10^0).

At a pressure of 100 kPa, vibrodynamic action caused a decrease in the shear resistance with respect to the static resistance, as in case initial shift, and in case of repeated. At a normal pressure of 200 kPa, in case of initial shear, the vibration slightly increased the shear resistance, and for the re-reduction it decreased. At a normal pressure of 300 kPa, the shear resistance under vibrodynamic action is practically invariant for the initial and repeated shifts, but is substantially less than the static resistance.

The results of tests of ground No. 3 are shown in figure 11. To more accurately determine the residual strength of the ground, all experiments were carried out with a second shift.

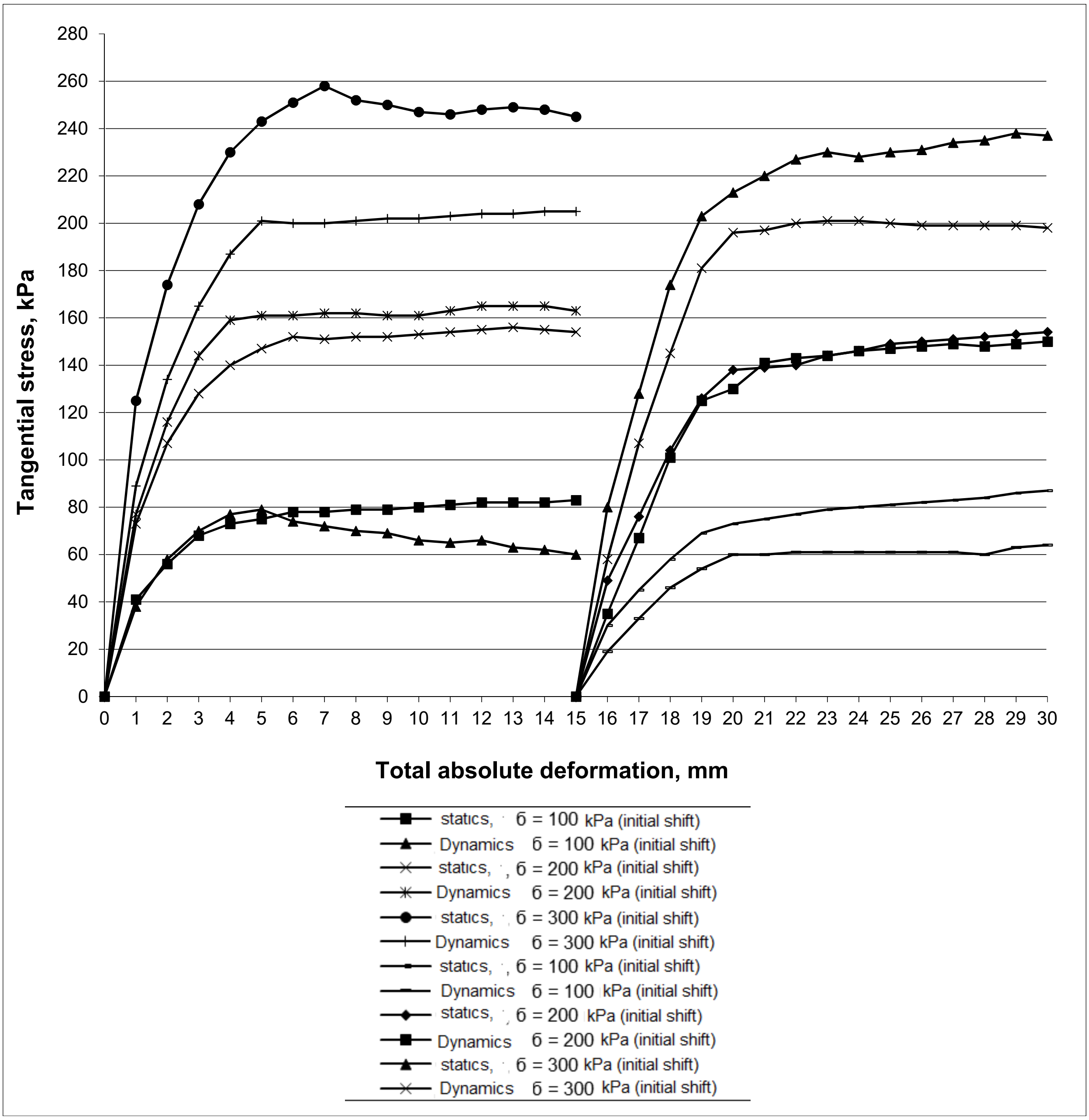

Figure 11 – Graph of the relationship between absolute strain and shear stress (ground number 3)

The shear diagrams for ground No. 3 are shown in figure 12. The following strength parameters were obtained during the test: the internal friction angle for peak strength in static tests is φ_{st}^{peak} =41^{0}11′, for residual φ_{st}^{res} =37^{0}3′, C_{st}^{res} =8,7kPa; at vibrodynamic tests for peak strength, the following parameters were set: φ_{din}^{peak} =32^{0}13′, C_{din}^{peak} =23.7 kPa; for the residual - φ_{din}^{res} =34^{0}25′, C_{din}^{res} =1.3 kPa.

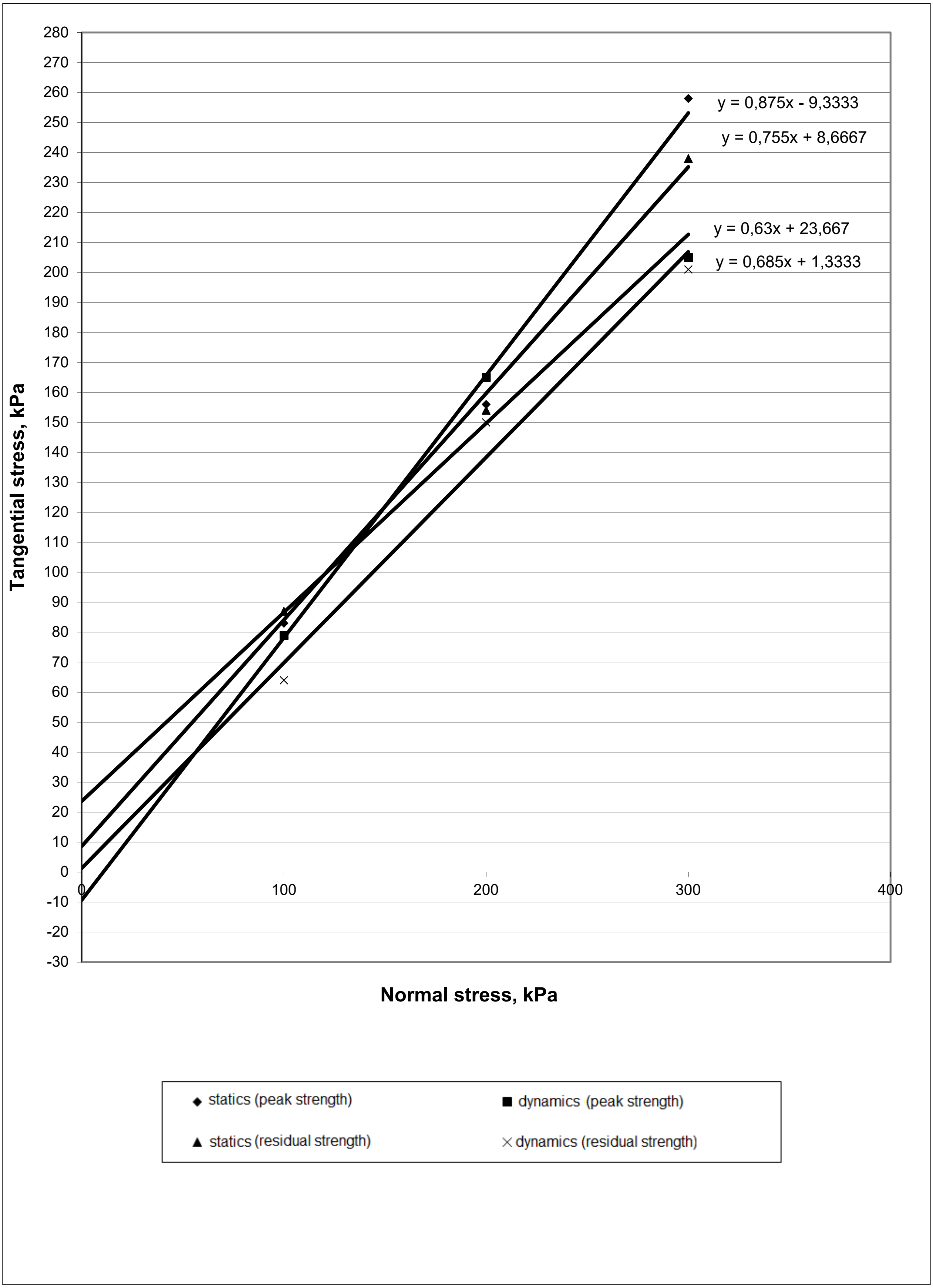

Figure 12 – Shear diagram (ground number 3)

In static tests, parameter φ for residual strength decreased by 10% with respect to peak strength, and parameter C, on the contrary, increased to 8.7 kPa.

When subjected to vibration, parameter φ for peak strength was 6.4% less than parameter φ for residual strength, but the adhesion C for residual strength decreased by 94.5% with respect to peak strength. With a second shift in vibrodynamic conditions, the adhesion decreased from 23.7 to 1.3 kPa.

The impact of the dynamic load reduced the value of the parameter φ by 21.8% for peak strength and by 7.1% for residual strength. Parameter C in determining the peak strength under vibrodynamic conditions increased to 23.7 kPa, and in determining the residual strength, it decreased by 85% (more than 6 times).

At a normal pressure of 100 kPa, vibration did not significantly affect the shear resistance for peak strength, but reduced the resistance for residual strength, both at the initial and after the second shear. At a pressure of 200 kPa, vibrodynamic action caused an increase in the peak strength of the soil, without affecting the residual strength. At a normal pressure of 300 kPa, the vibration caused a significant decrease in the shear resistance with respect to the static, both for the peak and for the residual strength at the initial and with the subsequent shear.

Amplitude changes in the normal stress Δσ when processing the results of tests of ground number 3 under conditions of vibrodynamic loading were not taken into account. The shift diagrams are constructed from the mean values of the normal stresses.

Conclusion.

1. The design features of the shear device and test procedure allowed establishing the certainty of the stress-strain state of ground sample:

- normal stress is recorded at the bottom of the sample, that is, the "actual" normal stress in the shear plane is measured;
- allowance for the variability of the contact surface area and the frictional force between the metal and the ground allows us to conclude that the "actual" tangential stress is measured in the shear plane;
- ability to achieve a relative strain of more than 27% of the samples and the possibility of a re-shift allow us to determine not only the "peak" but also the "residual" strength of clay soils.

2. The instrument, the test procedure and control and measuring equipment (CME), servicing device, can be used in studies to determine the vibrodynamic effect on the strength parameters of the ground.

3. For the conditions of plane deformation, both with static and vibrodynamic influences, in the limit state, resistance shear characteristics of the non-saturated cohesive grounds, subject to the law of dry Coulomb friction, are established. The parameter $\varphi_к$ to the equation of limiting equilibrium is constant and determined by the real composition of the ground.

4. In the sense of Sh. Coulomb's representations, the angle of internal friction and connectivity of non-saturated normal-packed clay grounds for the conditions of static and vibrodynamic loading is invariant. It has been confirmed that the change in the shear resistance of clay grounds under vibro-dynamic influences depends on the change in the stress state.

5. The shear resistance of the clayey grounds considered in the work under static and vibrodynamic influences depends on the type and nature of the contact interactions between the ground particles and the possibility of changes in the shear process. At the same time, humidity is one of the main factors affecting the nature of water-colloidal bonds in the ground and the shear resistance under static and vibrodynamic effects.

6. Shear resistance of non-saturated primaries is characterized by peak and residual strength both under static and vibrodynamic influences. The peak and residual strength of grounds depends on the history of their stressed state in the process of formation in the natural environment.

М. В. Дудкин[1], Б. Апшикур[1], А. И. Ким[1], Т. Т. Ипалаков[1], Е. А. Асангалиев[1], М. Млынчак[2]

[1]Д. Серікбаев Шығыс Қазақстан мемлекеттік техникалық университеті, Өскемен, Қазақстан,
[2]Вроцлав ғылым және технология университеті, Польша

ТЕМІР ЖОЛ КОНСТРУКЦИЯСЫНДА НЕМЕСЕ ОНЫҢ ЖЕКЕЛЕГЕН ЭЛЕМЕНТТЕРІНІҢ ЖҰМЫСЫНДА БОЛЫП ЖАТҚАН ПРОЦЕСТЕРДІ СИПАТТАЙТЫН ТОПЫРАҚТЫ ЫҒЫСТЫРУҒА ЖӘНЕ МАТЕМАТИКАЛЫҚ МОДЕЛЬДЕРГЕ СЫНАУҒА АРНАЛҒАН ҚОНДЫРҒЫНЫ ӘЗІРЛЕУ

Аннотация. Жұмыста пойыздық жүктемені және поездар қозғалысының қарқындылығын модельдеу мүмкіндігімен түрлі типті сазды топырақтардың беріктілік және деформациялық параметрлеріне дірілдинамикалық және пульсациялаушы жүктеулердің әсерін ескере отырып, нақты бастапқы деректерді анықтау мақсатында топырақты ығыстыруға сынауға арналған қондырғы әзірленді.

Түйін сөздер: топырақ, үйінді, темір жол, жер төсемі, ығыстыру.

М. В. Дудкин[1], Б. Апшикур[1], А. И. Ким[1], Т. Т. Ипалаков[1], Е. А. Асангалиев[1], М. Mlynczak[2]

[1]Восточно-Казахстанский государственный технический университет им. Д. Серикбаева,
Усть-Каменогорск, Казахстан,
[2]Вроцлавский университет науки и технологии, Польша

РАЗРАБОТКА УСТАНОВКИ ДЛЯ ИСПЫТАНИЙ ГРУНТОВ НА СДВИГ И МАТЕМАТИЧЕСКИХ МОДЕЛЕЙ, ОПИСЫВАЮЩИХ ПРОЦЕССЫ, ПРОИСХОДЯЩИЕ В КОНСТРУКЦИИ ЖЕЛЕЗНОДОРОЖНОГО ПУТИ В ЦЕЛОМ, ИЛИ В РАБОТЕ ЕГО ОТДЕЛЬНЫХ ЭЛЕМЕНТОВ

Аннотация. Дано описание установки для испытаний грунтов на сдвиг с целью определения достоверных исходных данных с учетом влияния вибродинамического и пульсирующего нагружений на прочностные и деформационные параметры глинистых грунтов различных типов с возможностью моделирования поездной нагрузки и интенсивности движения поездов.

Ключевые слова: грунт, насыпь, железнодорожный путь, земляное полотно, сдвиг.

Information about authors:

Doudkin Mikhail Vasilyevich, Doctor of Technical Sciences, Professor, Dean of the Faculty of Engineering at D. Serikbayev East Kazakhstan state technical university, Ust-Kamenogorsk, Kazakhstan; doudkin@mail.ru; http://orcid.org/0000-0001-5732-0724

Apshikur Baytak, Cand. Of tech. sc., Associate Professor of the Department "Geology, Land Management and Cadastre" D. Serikbayev East Kazakhstan state technical university, Ust-Kamenogorsk, Kazakhstan; bapshikur@ektu.kz; https://orcid.org/0000-0003-4353-4072

Kim Alina Igorevna, PhD, associate professor of the department "Technological machines and transport" D. Serikbayev East Kazakhstan state technical university, Ust-Kamenogorsk, Kazakhstan; k.a.i.90@mail.ru; https://orcid.org/0000-0002-9332-4279

Ipalakov Tulegen Tursunovich, Doctor of Technical Sciences, Professor of the Department "Geology, Land Management and Cadastre" D. Serikbayev East Kazakhstan state technical university, Ust-Kamenogorsk, Kazakhstan; tipalakov@ektu.kz; https://orcid.org/0000-0001-7587-7585

Asangaliev Elibek Atrauovich, Ph.D., Associate Professor of the Department "Water and Forest Resources" D. Serikbayev East Kazakhstan state technical university, Ust-Kamenogorsk, Kazakhstan; elibek60@mail.ru; https://orcid.org/0000-0003-4002-8350

Mlynczak Marek, Hab. Dr., professor of Wroclaw university of science and technology, e-mail: mlymar@gmail.com; https://orcid.org/0000-0002-1134-3477

REFERENCES

[1] Szczesniak W. Analiz astatyezna, dynamicz na I stateczno senawierzchni drogowej I kolejowej // Warsaw Univ. Technol. Fac. Civ. Ehg. Warsaw, 1999. P. 369-395 (in Polish).

[2] Bojko A., Fedotov A.I., Khalezov W.P., Młyńczak M. Analysis of brake testing methods in vehicle safety. Safety and Reliability: Methodology and Applications – Proceedings of the European Safety and Reliability Conference, ESREL 2014.

[3] Kim A., Doudkin M., Vavilov A., Guryanov G.. New vibroscreen with additional feed elements // Archives of Civil and Mechanical Engineering. September 2017. Vol. 17, Issue 4. P. 786-794. © PolitechnikaWrocławska. https://doi.org/10.1016/j.acme.2017.02.009 (in Eng.).

[4] Stryczek J., Banaś M., Krawczyk J., Marciniak L., Stryczek P. The Fluid Power Elements and Systems Made of Plastics // Procedia Ingineering. 176 (2017) 600-609. Published by Elsevier Ltd., www.elsevier.com/locate/procedia

[5] Doudkin M., Vavilov A., Pichugin S., Fadeev S. Calculation of the interaction of working body of road machine with the surface // Life Science Journal. 133 (2013). 832-837. http://www.lifesciencesite.com.133 (in Eng.).

[6] Shahunjanc G.M. (1969) Zheleznodorozhnyj put. Transport, Russia (in Russ.).

[7] Jakovleva T.G. (1999) Zheleznodorozhnyj put. Transport, Russia (in Russ.).

[8] Maslov N.N. (1977) Mehanikagruntov v praktikestroitelstva. Strojizdat, Russia (in Russ.).

[9] Maslov N.N. (1982) Osnovyinzhenernojgeologii i mehanikigruntov. Vysshajashkola, Russia (in Russ.).

[10] Podpalov A.F., Chernyshov M.A., Titov V.P. (1978) Spravochnik po zemljanomu polotnu jekspluatiruemyh zheleznyh dorog. Transport, Russia (in Russ.).

[11] Torue T., Hajasari M., Kitahara J. Dymanic deformation and failure characteristics of rochfill material subjected to cyclic shear loading under vertical vibration. Soils and Foundations // Japanese Society of Soil Mechanics and Foundation Engenering. 1980. Vol. 20, N 4. P. 1-17 (in Eng.).

[12] Ivashov V.I., Kapovsky B.R., Plyasheshnik P.I., Pchelkina V.A., Iskakova E.L., Nurmukhanbetova D.E. (2018) Mathematical simulation of one-stage grinding of products frozen in blocks // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. Vol. 5, N 431 (2018). P. 48-65. https://doi.org/10.32014/2018.2518-170X.9 ISSN 2518-170X (Online), ISSN 2224-5278 (Print).

[13] Giel R., Młyńczak M., Plewa M. Evaluation method of the waste processing system operation // Risk, Reliability and Safety: Innovating Theory and Practice - Proceedings of the 26th European Safety and Reliability Conference, ESREL 2016;

[14] Fedotov A.I., Młyńczak M. Simulation and experimental analysis of quality control of vehicle brake systems using flat plate tester. Advances in Intelligent Systems and Computing. 2016.

[15] Porevski R., Ponagelis I. Evaluation of variability in sulgrade loads // J. Civ. Eng. and Manag. 2003. Vol. 9, N 1. P. 16-19.

[16] Skempton A. Effective stress in soils, concrete and rocks. Conference on pore pressure. Londres, 1960.

[17] Habib P. La resistance an cisaillement des sols, Annales de l'Institut Technique du Batimentet des Travaux Publics, SixiemeAnnec, N 61 (Sds et Fondations No. 12). Paris, 1-40 (1953-a).

[18] Casagrande A., Wilson D. Testing Equipment, Techniques and Errors, Moderators Report Session 2, ASCE Research Conference on Shear Strength of Cohesive Soils, University of Colorado, 1123-1130 (1960).

[19] Sakimov M.A., Ozhikenova A.K., Abdeyev B.M., Doudkin M.V., Ozhiken A.K., Azamatkyzy S. Finding allowable deformation of the road roller shell with variable curvature // News of the National academy of sciences of the Republic of Kazakhstan. Series of Geology and Technical Sciences. 3(429). P. 197-207 http://www.geolog-technical.kz/images/pdf/g20183/197-207.pdf

[20] Wang Y., Wu H.C. and Li V.C. Concrete reinforcement with recycled fibers // Journal of Materials in Civil Engineering. 2000. 12:314-319. http://dx.doi.org/10.1061/(ASCE)0899-1561(2000)12:4(314).

[21] Doudkin M.V., Fadeyev S.N., Pichugin S.Yu. (2013) Contact force calculation of the machine operational point // Life Science Journal. 10(39): 246-250. http://www.lifesciencesite.com. 39 (in Eng.).

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайте:

www:nauka-nanrk.kz

ISSN 2518-170X (Online), ISSN 2224-5278 (Print)

http://www.geolog-technical.kz/index.php/en/

Верстка *Д. Н. Калкабековой*

Подписано в печать 15.11.2019.
Формат 70x881/8. Бумага офсетная. Печать – ризограф.
19,7 п.л. Тираж 300. Заказ 6.

Национальная академия наук РК
050010, Алматы, ул. Шевченко 28, т. 272-13-19, 272-13-18