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ҚАЙЫРЫМДЫЛЫҚ ҚОРЫ HALYK CHARITY FOUNDATION

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

N E W S

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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.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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INFLUENCE OF METEOROLOGICAL FACTORS ON THE ACCURACY OF MONITORING RESULTS

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Abstract. *Purpose* of this article is to identify factors affecting accuracy of geodetic measurements and ways to weaken them, which ensures monitoring quality of engineering objects. *Methodology*. Work used integrated approach, including: natural conditions, location of controlled object, monitoring and assessment of its accuracy**.** *Results*. Deformation of berth structures of the North Caspian Sea Canal, which is under the Tengizchevroil LLP Project is being monitored. With intensive oil production in the Northern Caspian, facility will be used to deliver cargo to onshore fields. Ensuring safe operation of such unique and critical engineering structures is achieved by conducting geodetic monitoring.Influence of meteorological factors on monitoring results of hydraulic structure of the North Caspian Sea Canal using various instruments was studied. Results of geodetic monitoring of berth structures using optical instruments, including electronic total station are presented. Deformation control method has been improved, which has led to improved methods and types of geodetic instruments in automated monitoring systems. Results obtained were used in PhD students dissertations,

as well as in educational process of Satbayev University. *Scientific novelty.* As a result of work carried out, methodology of consideration of meteorological factors during monitoring engineering structures was introduced into production and educational process. *Practical effect.* Consideration of meteorological factors during monitoring engineering structures makes it possible to increase monitoring accuracy. Results obtained can be used to improve quality of monitoring results in production conditions. Practical significance also lies in introduction into production of high-precision geodetic methods of monitoring systems during construction of engineering structures.

Keywords: Caspian Sea Canal, berthing structures, objects deformations of geodetic network, monitoring, geodetic instruments, accuracy assessment

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МЕТЕОРОЛОГИЯЛЫҚ ФАКТОРЛАРДЫҢ МОНИТОРИНГ НӘТИЖЕЛЕРІНІҢ ДӘЛДІГІНЕ ӘСЕРІ

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Аннотация. *Бұл мақаланың мақсаты инженерлік объектілердің мониторингінің сапасын қамтамасыз ететін геодезиялық өлшеулердің дәлдігіне және оларды әлсірету жолдарына әсер ететін факторларды анықтау болып табылады. Әдістемесі. Жұмыста кешенді тәсіл қолданылды, оның ішінде: бақыланатын объектінің табиғи жағдайлары, мониторинг жүргізу және оның дәлдігін бағалау. Нәтижелері. "Теңізшевройл" ЖШС жобасы бойынша тұрған Солтүстік Каспий теңіз каналының айлақтық құрылыстарының деформациясына мониторинг жүргізілуде. Солтүстік Каспийде қарқынды мұнай өндіру кезінде бұл нысан*

жүктерді жерүсті кен орындарына жеткізу үшін пайдаланылатын болады. Осындай бірегей және жауапты инженерлік құрылыстарды қауіпсіз пайдалануды қамтамасыз етуге геодезиялық мониторинг жүргізу арқылы қол жеткізіледі. Солтүстік Каспий теңіз каналының гидротехникалық құрылысының мониторинг нәтижелеріне метеорологиялық факторлардың әсері әртүрлі аспаптармен зерттелді. Айлақ құрылыстарына оптикалық аспаптармен, оның ішінде электрондық тахеометрмен жүргізілген геодезиялық мониторингтің нәтижелері келтірілген. Автоматтандырылған бақылау жүйелерінде геодезиялық құралдардың әдістері мен түрлерін жақсартуға әкелген деформацияны бақылау әдісі жетілдірілді. Алынған нәтижелер докторанттардың диссертациялық жұмыстарында, сондай-ақ Satbayev University оқу процесінде пайдаланылды. Ғылыми жаңалық. Жүргізілген жұмыстардың нәтижесінде инженерлік құрылыстарды мониторингілеу кезінде метеорологиялық факторларды есепке алу әдістемесі өндіріске және оқу процесіне енгізілді. Практикалық құндылық. Гидротехникалық құрылыстарды мониторингтеу кезінде метеорологиялық факторларды есепке алу мониторингтің дәлдігін арттыруға мүмкіндік береді. Алынған нәтижелер өндірістік жағдайларда мониторинг нәтижелерінің сапалық деңгейін арттыру үшін пайдаланылуы мүмкін. Практикалық маңыздылығы сонымен қатар инженерлік құрылыстарды салу кезінде мониторинг жүйесінің жоғары дәлдіктегі геодезиялық әдістерін өндіріске енгізуден тұрады.

Түйін сөздер: *Каспий теңіз каналы, айлақ құрылыстары, объектілердің деформациясы, геодезиялық желі, мониторинг, Геодезиялық аспаптар, дәлдікті бағалау*

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ВЛИЯНИЕ МЕТЕОРОЛОГИЧЕСКИХ ФАКТОРОВ НА ТОЧНОСТЬ РЕЗУЛЬТАТОВ МОНИТОРИНГА

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Аннотация. Целью данной статьи является выявление факторов, влияющих на точность геодезических измерений и путей их ослабления, которая обеспечивает качество мониторинга инженерных объектов. В работе использован комплексный подход, включающий: природные условия расположения контролируемого объекта, проведение мониторинга и оценка его точности. Ведется мониторинг деформации причальных сооружений Северо Каспийского морского канала, стоящегося по Проекту ТОО «Тенгизшевройл». При интенсивной добычи нефти на Северном Каспии, объект будет использоваться для доставки грузов на наземные месторождения. Обеспечение безопасной эксплуатации таких уникальных и ответственных инженерных сооружений достигается проведением геодезического мониторинга. В статье исследовано влияние метеорологических факторов на результаты мониторинга гидротехнического сооружения Северо-Каспийского морского канала различными приборами. Приведены результаты, проведенного геодезического мониторингапричальных сооружений оптическими приборами, в том числе электронным тахеометром. Усовершенствован метод контроля деформации, который привел к улучшению методов и видов геодезических инструментов в автоматизированных системах мониторинга. Полученные результаты использованы диссертационных работах докторантов, а также в учебном процессе Satbayev University. Внедрены в производство и в учебный прпоцесс методика учета метеорологических факторов при мониторинге инженерных сооружений. Практическая ценность исследвания состоит в том, что учет метеорологических факторов при мониторинге гидротехнических сооружений, позволяет повысить точность мониторинга. Полученные результаты могут быть использованы для повышения качественного уровня результатов мониторинга на производственных условиях. Практическая значимость также заключается во внедрении в производство высокоточных геодезических методов системы мониторинга при строительстве инженерных сооружений.

Ключевые слова: Каспийский морской канал, причальные сооружения, деформации объектов, геодезическая сеть, мониторинг, геодезические приборы, оценка точности

Introduction

For oil industry specialists, it is becoming increasingly clear that resolving issues such as reservoir pressure and subsidence of the earth's surface is unthinkable without monitoring the state of rock mass and stability of engineering structures using modern geodetic methods.

Described situation is typical for giant Tengiz oil field and the North Caspian Sea Canal, which is under the Tengizchevroil LLP Project.

Therefore, introduction of new generation devices into practice can be called the

most significant technological innovation in the 21st century in surveying, geodesy and a number of related industries.

Goal setting. Goals and objectives of monitoring geodynamic state of subsoil and solving problem of ensuring geodynamic safety of development of hydrocarbon raw materials and unique construction projects on territory of fields must be met by adequate construction of observation systems and organization of monitoring observations on them for entire period of field development. Potential forms of occurrence of natural and natural-technogenic events determine choice of adequate basic set of methods for monitoring these processes, use of which must be planned already at the first stage of monitoring with subsequent adjustment depending on results obtained.

During monitoring following specific requirements arise: 1) raising public awareness of results; 2) raising efficiency of observations; 3) economic efficiency of researches. From this position goal has been set, idea has been justified, and tasks of researches of the Department of Surveying and Geodesy of the K.I. Satbayev KazNRTU at the Tengiz fields have been formulated.

Currently, according to special project of «Tengizchevroil» LLP, the North Caspian Sea Canal with berthing facilities for transportation of goods is being built in Kazakhstan. In parallel, geodetic monitoring was carried out for this hydraulic structure. The project provides for the following structures: sea channel; reversal pool; areas of sea dump of soil; berthing facilities for discharging cargo (FDC); dump site for soil and sedimentation basin; an access road, etc. The North Caspian Sea Canal will be used to transport cargo in support of construction operations and to help oil fields and industrial enterprises in the West Kazakhstan region of Kazakhstan.

Kazakhstan, possessing huge underground resources, strives to actively develop its economy and other important areas of the republic. In recent decades, country has taken important step towards increasing exports and imports of raw and finished products by opening sea channels and ports in the north of the Caspian Sea. However, successful development of this area depends not only on volume of exports and imports, but also on safety and reliability of transport hubs, such as hydraulic structures. Reliable monitoring methods are required to ensure safety and security of port facilities. Improvement in methods for monitoring deformations leads to expansion of methods and types of geodetic instruments in automated monitoring systems. Technology improvement is characterized by full automation, continuous measurements, high accuracy and reliability of results (The project, 2017).

Now it is necessary to take more organized approach to other factors that affect measurement accuracy and overall monitoring picture, since incorrectly placed sensor or reflector can provide incorrect information. It is also important to pay special attention to important aspects of observed structure and to possible factors that affect object, for example, thermal expansion, and concering of hydraulic structures, tides, etc. Correct placement of sensors (reflectors) on the object's structures plays significant role (Leica Geosystems, 2023; Evangelia Lambrou et al., 20215: 5).

Geodetic measurements themselves also have some nuances. Network construction

scheme, atmospheric indicators, instrument accuracy and measurement frequency play a huge role in obtaining necessary data.

1. **Accuracy influence of measuring devices**. To date most popular models on the market are models with mean-square error (MSE) for angles measurement of 5", 3", 2", 1". Accuracy of measuring distance to prism reflector in most tacheometers is the same, which is 1.0 mm + 1.5 ppm at 2 circles of measurement (Kyrgizbaeva, 2023: 200; Myngzhassarov, 2020: 5).

Figure 1 shows diagram for determining errors of measuring with a total station.

Tables 1 and 2 show accuracy characteristics of popular modern tacheometers. Based on tables above, it can be determined that measurements, depending on use of certain tacheometers and measurement range, will have errors inside blue ellipse in Figure 1. Accordingly, it is necessary to choose optimal tacheometer model for reference measurement scheme, considering distances to targets and possible amount of deformation.

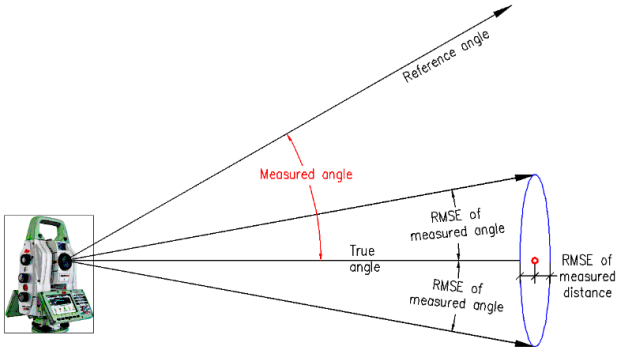


Fig. 1 - Determination of measurement error with electronic total station

Table 1 - Determination of measurement error with electronic total station with accuracy of 5"

For tacheometers with angular accuracy of 5", when measuring on a prism reflector			
Distance to the point, in m	Angular RMSE, in mm	Linear RMSE, in mm	Overall RMSE, in mm
20	0.48	1.03	1.51
50	1.21	1.075	2.29
100	2.42	1.15	3.57
150	3.64	1.225	4.86
200	4.85	1.3	6.15
250	6.06	1.375	7.44
500	12.12	1.75	13.87
1000	24.24	2.5	26.74

Table 2 - Determination of measurement error with electronic total station with accuracy of 1"

For tacheometers with angular accuracy of 1", when measuring on a prism reflector			
Distance to the point, in mm.	Angular RMSE, in mm.	Linear RMSE, in mm.	Overall RMSE, in mm.
20	0.10	1.03	1.13
50	0.24	1.075	1.32

100	0.48	1.15	1.63
150	0.73	1.225	1.95
200	0.97	1.3	2.27
250	1.21	1.375	2.59
500	2.42	1.75	4.17
1000	4.85	2.5	7.35

2. Influence of meteorological factors on accuracy of geodetic measurements

Atmosphere pressure. Changes in atmospheric pressure can affect accuracy of geodetic measurements. High atmospheric pressure can increase atmosphere density, which can distort path of laser light or radio waves used in geodetic measurements. Therefore, during measurements process, it is important to consider current atmospheric pressure and its changes over time.

Humidity. Air humidity can affect optical measurements and laser measurements. Humid air can cause dispersion of laser beam or change optical properties of environment, which can lead to distortion of measurement data. This is especially important when using laser rangefinders and theodolites, where measuring accuracy depends on atmosphere properties.

Temperature. Temperature changes can cause deformation in surveying instruments. This can affect expansion or contraction of control points and markers, which in turn can add uncertainty to measurements. Accuracy of height and angle measurements can also be affected by temperature, as changes in temperature can cause distortion in optical systems. To prevent this, geodetic umbrella should be used during conduction high-precision measurements (Al Fatin, 2021: 18).

Meteorological factors can significantly influence accuracy of geodetic measurements. Therefore, to achieve high accuracy and reliability of geodetic measurements, it is necessary to consider and correct these atmospheric factors during the measurement process.

Frequent problem with this type of monitoring is that atmospheric parameters are measured only at station, although beam can pass over surface of water and other objects where meteorological data varies. Solution to problem can be measuring weather data at different points, for example in the middle of beam and near target, then these corrections are entered into the total station. In this way, gross errors in measurements can be avoided.

The above methods and methods were evaluated during monitoring berth structures (Fig. 2), located on the north-eastern side of the Caspian Sea, on the Prorva Peninsula. Berth structures are part of a group of hydraulic structures, such as a sea canal, turning basin and protective fortified dams. According to SNiP RK 3.02-05-2010, berth structures belong to buildings and structures of III class of responsibility, and monitoring is accordingly required (Nurpeisova et. al., 2021: 6).

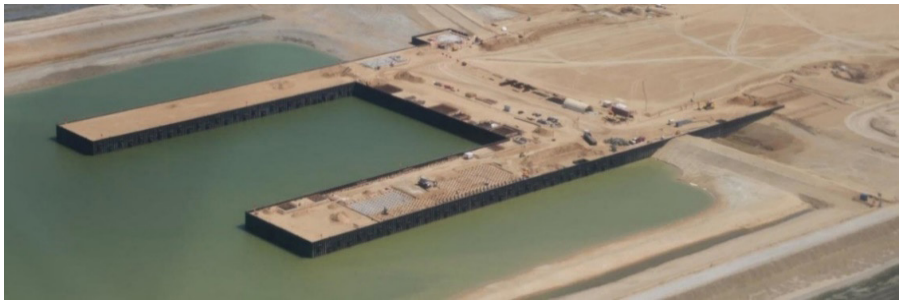
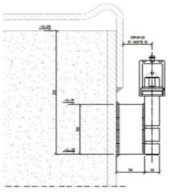


Figure 2 – Berting structures of the sea channel

During drawing up a project for production of geodetic monitoring of hydraulic structures, points that would be most susceptible to deformation were determined (Fig. 3, a), as well as type of monitoring signs (Fig. 3, b and 3, c).

a

б



c

Fig. 3: a- Scheme of installation of monitoring points on berths;
b and c – type of brand and method of installation on structures

Points MP1 – MP13 are used as monitoring marks. Points ST1, BS1, BS2, BS3 are used as reference points. Reference points are concrete piles immersed in the ground, with a cross-section of 40*40cm and a length of 3m.

At the reference points, before monitoring start tacheometric traverse was conducted. The entire monitoring process and initial measurements were conducted using a Leica TS16 total station, with an accuracy of 1”. Orientation and direct measurements were conducted on 2 circles.

After marks were installed, month later, in April 2019, initial measurements were taken at the monitoring points. Since core network is equal, it was possible to choose any

of the reference points as a station. The zero-stage data was obtained from measurements from point BS1, since it is the most convenient in terms of installing tacheometer. During the second stage of measurement, it was decided to make control measurements from point ST1. Measurements from two stations were made on the same day, temperature difference between stations is +3° (Fig. 3). A Leica Geosystems GMP111–0 prism mini reflector with a height of 400 mm was used as a reflector.

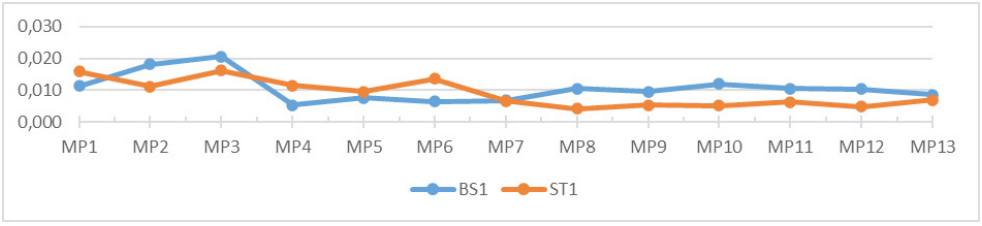


Fig.-3. Measurement results from stations BS1 and ST1

From the above figure it can be observed that monitoring points MP1, MP2, MP3 have the greatest differences with initial measurements at both observation stations, since they are the farthest ≈250m, and remaining points are within "acceptable" standards.

Following factors that can influence measurements from point BS1:

• laser beam passes at a relatively low distance from the heated surface, at a height of 0.2m – 1.3m, which also plays key role;

• station is located at a distance of +150m from each point;

• all monitoring points are located above the water surface, therefore humidity at the station and measurement points are different.

If we consider above factors, then filming from remaining 2 stations should show greater difference at opposite points. For this, the next day measurements were made from stations BS2, BS3. Observation results are shown in Fig. 4.

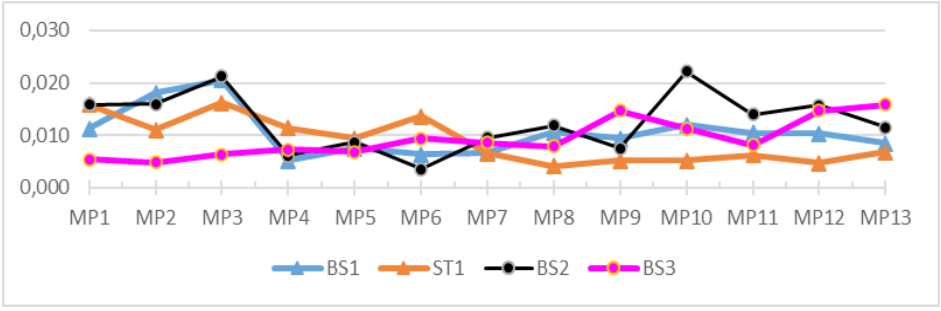


Fig.4 - Measurement results from station BS1 and ST1, BS2 and BS3

It is clear from figures that the farthest points have largest errors; accordingly, when taking measurements in unfavorable weather conditions, it is necessary to consider distance from tacheometer to monitoring marks.

All the above measurements were conducted in the morning, recording weather conditions, namely temperature, relative humidity and atmospheric pressure. It was noticed that the hygrometer readings at stations BS1 and BS2 differ from hygrometer readings at monitoring purposes and stations BS3 and ST1 by 8–10 % relative humidity. This can be explained by fact that targets and stations BS3 and ST1 are located above the water surface, respectively, this affects the accuracy of the measurement. After conducting measurements at all stations and analyzing survey data and weather conditions, it was decided to conduct further measurements from station ST1. Further monitoring was conducted every month, by one team of performers and using one set of equipment (Fig. 5).

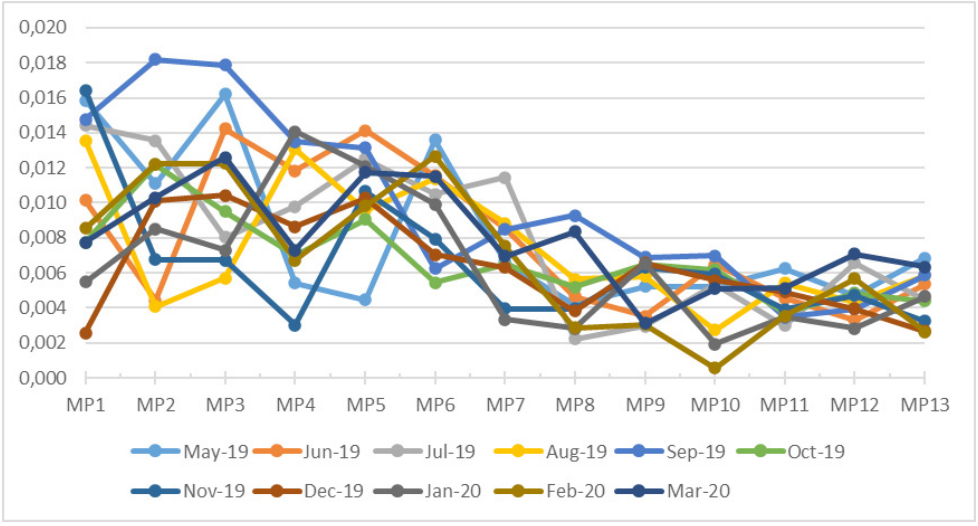


Fig.5 - Results of monthly measurements from station ST1

According to the program for monitoring deformation of berth structures, from moment of commissioning, monitoring was conducted at intervals of 1 month throughout the year, then, based on measurement results, no critical deformations were detected, and frequency was reduced accordingly (Nurpeisova et. al., 2020: 3).

Conclusions

Geodetic monitoring is key tool for ensuring safety and efficient operation of berth structures. It allows you to monitor the deformations and movements of structures in real time, detect possible threats and risks associated with their condition, and take timely measures to prevent emergency situations. Geodetic monitoring systems allow you to save money and resources, eliminating need for expensive repairs and restorations. They also help extend life of structures, which is important for infrastructure sustainability and economic development of the region.

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