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НИВЕЛИРОВАНИЕ ВЕРТИКАЛЬНОГО СМЕЩЕНИЯ МОСТА НА РЕКЕ КАРА-УНКУР ВО ВРЕМЯ НАГРУЗОЧНОГО ИСПЫТАНИЯ

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Анализ и мониторинг деформации – очень важная часть геодезии для определения состояния инженерных, транспортных сооружений, таких как мосты. Поскольку мосты являются основными сооружениями на дороге, ежегодно в Кыргызстане проводятся испытания более 20 мостов во всех регионах. Приведены результаты геодезических наблюдений при проведении испытаний моста на реке Кара-Ункур, расположенного в Базар-Коргонском районе Жалал-Абадской области. Описаны геодезические методы, в частности, метод нивелирования с помощью точного автоматического нивелира NA 730.

Ключевые слова: анализ деформаций моста; вертикальное смещение; тахеометрическая съемка; нивелир.

КАРА ҮҢКҮР ДАРЫЯСЫНДАГЫ КӨПҮРӨНҮН ЖҮК КӨТӨРҮМДҮҮЛҮГҮН СЫНОО УЧУРУНДА АНЫН ТИГИНЕН ЖЫЛЫШУУСУН НИВЕЛИРЛӨӨ

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Көпүрөлөрдүн жана башка инженердик, транспорттук курулмалардын абалын аныктоо үчүн геодезиянын эң маанилүү бөлүгү болуп алардын майышуусуна талдоо жана мониторинг жүргүзүү эсептелет. Көпүрөлөр жолдогу эң негизги курулмалар болуп эсептелгендиктен, Кыргызстанда жыл сайын бардык аймактарда 20дан ашык көпүрө сыноодон өтөт. Бул макалада Жалал-Абад облусунун Базар-Коргон районунда жайгашкан Кара-Үңкүр дарыясындагы көпүрөнү сыноодон өткөрүүдөгү геодезиялык байкоолордун жыйынтыктары көрсөтүлдү. Геодезиялык методдор, тактап айтканда, NA730 так автоматтык ниверлөөнүн жардамы менен ниверлөө методу сүрөттөлдү.

Түйүндүү сөздөр: көпүрөнүн майышуусун изилдөө; тигинен жылышуу; тахеометрикалык сүрөткө тартуу; нивелир.

SURVEYING OF VERTICAL DISPLACEMENT OF A BRIDGE ON THE KARA-UNKUR RIVER DURING A LOAD TEST

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Deformation analysis is very important for detecting heath status of large engineering structures, such as bridges. Bridges are the main constructions on the road. Every year in Kyrgyzstan have tested more than 20 bridges of all regions. This paper describes the results of geodetic measurements of bridge on the Kara-Unkur River situated in Bazar-Korgon district of the Jalal-Abad region. Geodetic methods, in particular, a leveling method by means of exact automatic level NA 730 are described.

Keywords: bridge analysis; vertical displacement; total station; level.

Introduction. The assessment of new bridges is becoming more important in the Kyrgyz Republic, as most infrastructure does not meet the requirements specified by the construction company. However, the actual condition or damage of the structures could rarely be detected using standard methods. The following paper outlines a geodetic method of damage detection for a problem occurring on a pre-stressed new metal bridge. This method uses for detecting vertical displacements caused by overload of the bridge. These displacements are determined using modern geodetic measurements [1].

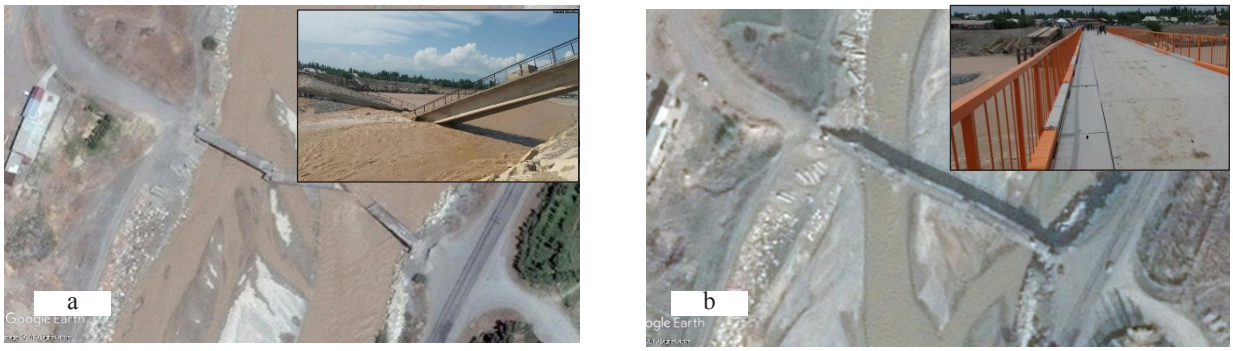

Fig. 1. The bridge on the Kara-Unkur River: a) old concrete bridge (source – http://akipress.kg), b) new metal bridge (source – http://novosti.kg)

Displacements and strains are due to external and internal influences such as wind force, effect of temperature changes, tectonic and seismic effects, changes in the amount of floor (ground) water, static and dynamic loading of objects, say in the form of folds, tilt, turn, distortion of the structures, and possible damage in the form of cracks and even fractures [2].

Examination of the structure (Fig. 1) or object as a measurement of displacement and strain to determine the change in the position and shape of the building, considering the environment, depending on the time. Basic indicators for the interpretation of measurement results are character, the direction and magnitude of displacement and strain, and we share in regard to the character in uniform and uneven shifts and the elastic and plastic deformation, in the light of changes in the direction of the horizontal and vertical and considering the size of the non-hazardous, tolerant, serious and critical [3]. Themeasurement of displacement and strain so necessary for assessment of the state of construction, assessment of the state of the object associated with the process of construction or production, or to repair or reinforcement structure and verify the accuracy of theoretical assumptions. The need for experimental testing occurs in the following cases [4]:

- the possibility of using the structure in case of exceeding the useful load,
- testing the durability of construction elements of mass production,
- tests of large and special facilities at the impact of useful load,
- tests of complex systems construction, and testing of its safety.

Study area. The bridge on the Kara-Unkur River in Mogol villageis one of biggest over Kara-Unkurriver in Bazar-Korgon rayon, Jalal-Abad oblast. The length of structure is 154 meter. The Bridge connects the center of Bazar-Korgon city with the Mogol village.

In June 11, 2017 destroyed due to a rising water in the river. Ministry of Emergency Situation officers inspected the bridge and gave the task to the Ministry of Transport and Roads to develop a new bridge project.In a short period, a new metal bridge project was developed. For the commissioning of the bridge, a number of technical checks were required. Employees of the departments “Geodesy and Geoinformatics” and “Roads and Railways, Bridges, Transport Tunnels” at the Kyrgyz State University of Construction, Transport and Architecture named after N. Isanov have conducted tests for the vertical loading.

Materials and methods. The stuff of Departments of “Geodesy and Geoinformatics” and “Roads and Railways, Bridges, Transport Tunnels” at the Kyrgyz State University of Construction, Transport and Architecture n.a. N. Isanov conduct geodetic surveys of bridges, tunnels and other road constructions. From 2005, stuff of second department conducted more than 100 survey tests in Kyrgyzstan and abroad. This year, two departments worked on testing the bridge, it was decided to conduct test trials using geodetic methods.

Vertical movements can measure in different ways and methods. What method will be used according to the kind of structures, needed accuracy, planned developments, external conditions, number of stuff. Displacement measurements usually performed using geodetic methods and leveling

Fig. 2. Scheme of leveling results –
Phase I (without load, before testing)

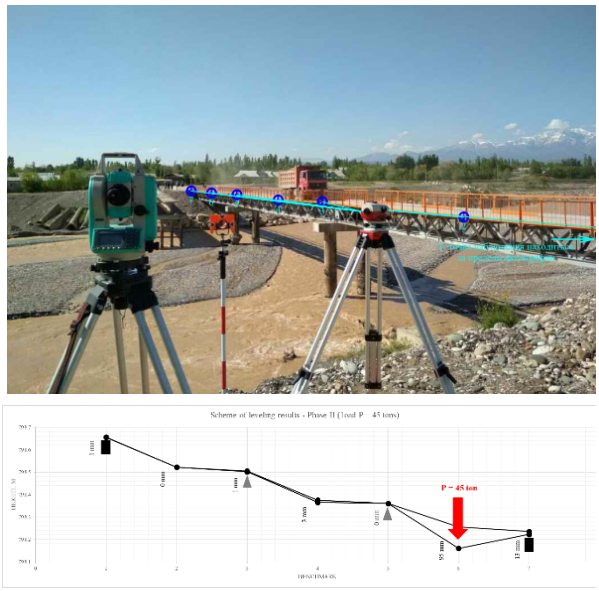

Fig. 3. Scheme of leveling results –
Phase II (1oad P = 45 tons)

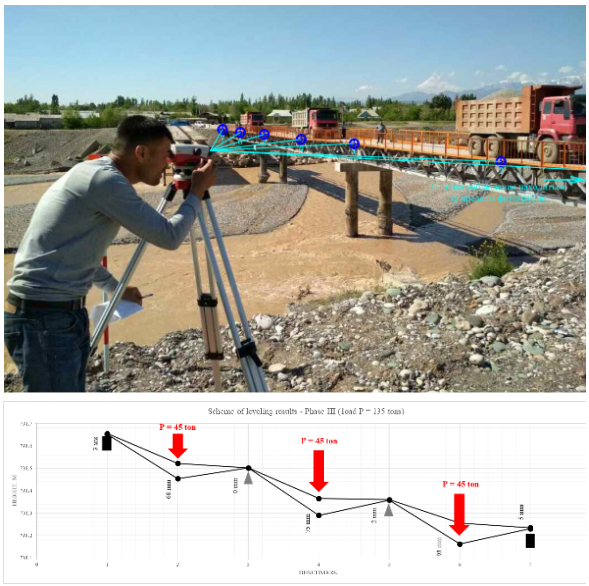

Fig. 4. Scheme of leveling results –
Phase III (1oad P = 135 tons)

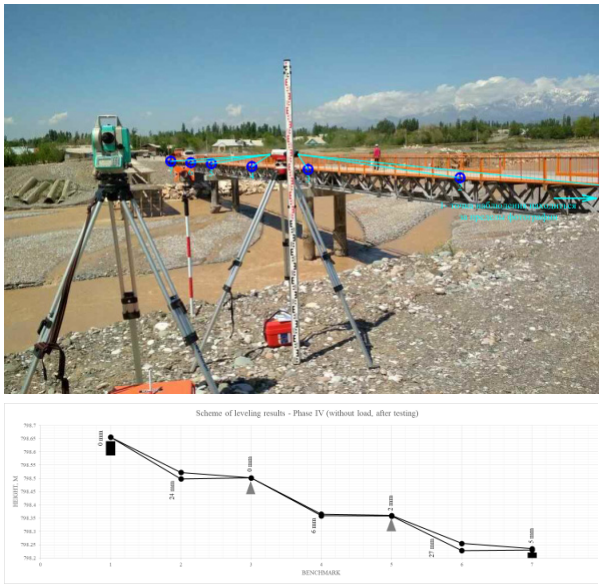

Fig. 5. Scheme of leveling results –
Phase VI (without load, after testing)

at higher and higher buildings this method, more we can give you results. To know which method we should know the characteristics of the structure, height of construction, length range etc.

This method is the oldest method of monitoring progress. So, method can give the indicators of only vertical movement with high accuracy. Leveling is so well known methods and the most used. In this method needs to be mindful that we have a point that is used for comparison to the field where we do not have a fixed displacement and strain so most times stabilize the bridge where there is no cargo and no oscillations.

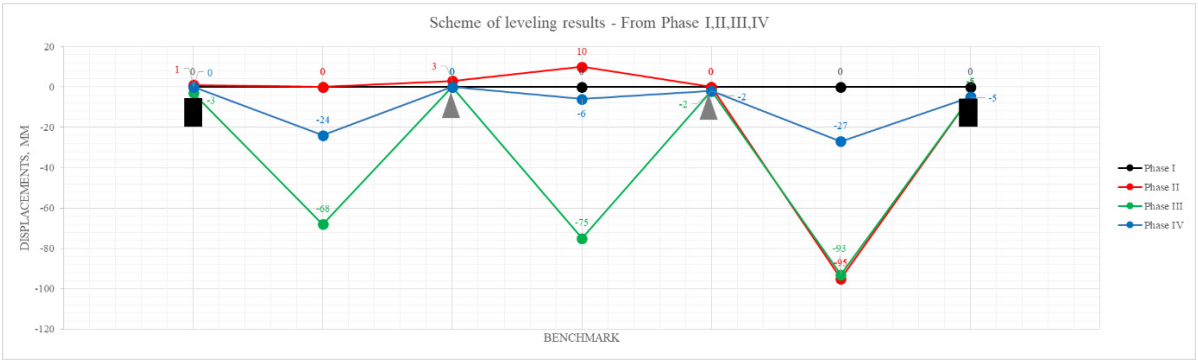

Fig. 6. The diagram of the loading phases I-IV

A set of equipment for performing measurement of detailed levelling on profiles of the bridge on the Kara-Unkur River consists: Leica automatic level NA 730, 2 aluminum rods with the spherical level, tripod, records of measurement, sketch and other accessories for computing. Calibration of Leica level NA 730 was made in Laboratory of the Geodesy and Geoinformatics Department, KSUCTA.

Special attention was paid to rectification of i angle, so that for all the instruments its value is reduced to the value less than 3″.

The working group for the realization of measurements consisted of one expert and two rod workers. The expert kept the measurement records and managed and led the activities of the working group. The rod workers were the operator with the instrument and the assistant in the working group.

Height differences were measured in relation to seven benchmarks 1, 2, 3, 4, 5, 6 and 7 from the side of Bazar-Korgon city. The measurements were carried out with different line of sight lengths. Loads were carried out in phases II and III. Phase IV referred to final result measurement without loads. A total of 4four load dispositions with P=45 tons each were carried out that lasted an average of 20 min.

Measurement data processing and values of bridge vertical movement. Measurement data processing and determination of vertical movement of bridge profiles with 7 measuring points include: calculating point heights on the profiles, forming differences and comparing the obtained values. The method of calculating vertical movement, within each phase, is conducted in the traverse of geometric levelling, related to the height of benchmarks H_1, H_2, H_3, H_4, H_5, H_6 and H_7. In order to determine heights at measuring points by profiles we first determined heights of binding points (geodetic point) .

$$H_{RP} = H_n + \Delta h \,. \qquad (1)$$

Based on the heights of binding points and read divisions of the rods . that stood on the binding points the heights of the line of sight were determined, separately for each station.

$$H_V = H_{RP} + l_n \,. \qquad (2)$$

For the disposition of the loading phase II and III differences in relation to the initial disposition were formed and shown in the diagram (Fig. 6)

The final and independent quality control of the data obtained was carried out by analyzing the results of measurements of the all profiles. By analyzing differences in all stages and load dispositions on the common profile 4 for all working groups, the mean value of differences of 1.41cm was established, which is within normal limits for this type of work.

Conclusion. Observations and testing of bridges aim to provide the proper technical maintenance of the bridge, to timely detect the resulting defects and create optimal conditions for their elimination. General inspection of bridges is done at least once every six years, and includes the inspection of: dilatation devices, protective bumpers and fencing, drainage, bearings and joints, corrosion protection, support structure of the bridge, pillars, geodetic control (supporting points and verticality of the pillars) and other elements whose observation is defined in a special manual on the bridge observation.

For the steel Bridge on the Kara-Unkurriver, it can be said that the first testing observation, was conducted at standard level. The need for testing was imposed in 2018 after finishing of building of bridge. The Bridge on the Kara-Unkurriver is a part

of the highway that goes through Mogol village, carrying the entire transit traffic in the Bazar-Korgon city. Complete building of the bridge lasted 12 months, including the observation of the structure under full load. A part of the observation was carried out using detailed levelling with different line of sight lengths. The size of deflection at the measuring points for realization of the load disposition is in the interval of +1,0 cm to –9,5 cm. The values obtained are consistent with the expected values confirming the stability of the steel structure, and on July 2018, the project of construction of the bridge was completed.

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