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**PASSAGE – OF ARCHITECTURAL PEARL OF ODESSA****ПАССАЖ - АРХИТЕКТУРНАЯ ЖЕМЧУЖИНА ОДЕССЫ****Yurkovsky R.G., / Юрковский Н.Е.***c.t.s, prof./к.т.н., проф.***Nakhmurov O.N., / Нахмуров А.Н.***c.t.s., as.prof. / к.т.н., доц.***Shishkalova N.Y., / Шишкалова Н.Е.***senior lecturer./ ст. препод.***Zakharchuk V.V., / Захарчук В.В.***senior lecturer, / ст. препод.***Kolomiets N.P., / Коломиец Н.П.***assistant / ассистент**Odessa State Academy of Civil Engineering and Architecture,**Odessa, Didrixsona 4. 65029**Одесская государственная академия строительства и архитектуры,**Одесса, ул. Дидрихсона 4, 65029*

**Abstract.** *In the center of the city Odessa at the intersection of Deribasovskaya and Preobrazhenskaya streets there is an architectural monument of the XIX century - "Passage". Due to changing technogenic and natural factors, the "Passage" building was constantly undergoing minor deformations. However, since 2009 the intensity of deformation of the building has increased. To study deformation processes, geodesic monitoring was organized to study the draft of the building. To quantify the sediment of the Passage building, a method of high-precision geometric leveling with the beams of the second class program with a precision electronic level Dini 12 and a bar-code strip was used. Analysis of the results of observations served as the basis for an objective identification of the alleged causes of sediment. The main cause of the deformations was the local soaking of the soil of the base of the building as a result of water leakage from the damaged (spoiled) water-bearing communications that pass from Deribasovskaya street through the entrance to the "Passage". After the reconstruction of water-bearing communications, deformation processes ceased. This made it possible to give recommendations on eliminating these causes and ensuring the normal operation of the building in the future. During the reconstruction of the street Preobrazhenskaya in 2017, the road surface was lifted to a depth of 1-1.5 meter, and the work was carried out by heavy road machinery and jackhammers. At the same time, reinforced concrete was started to reinforce the foundations of the "Passage" interior, also with the use of jackhammers in conjunction with existing foundations. The appearance of new cracks is presumably a consequence of these vibrational processes. Recent observations of the sediments of the building, carried out in March 2018, found discrete subsidence of up to 12-30 mm for almost half a year. Simultaneously, the electronic total station Nivo measured the roll of the outer walls of the main facades of the building. Calculation of the rolls was carried out by the method of coordinates. Roll in the direction of Preobrazhenskaya street reaches 311 mm.*

**Keywords:** *water-bearing communications, geodetic monitoring, geometric leveling, deformation processes, roll, building sludge.*

**Вступление.** The ancient building of the Odessa "Passage", was built in 1898-1899, located in the city centre (on the corner of Preobrazhenskaya and Deribasovskaya streets) and one of the most beautiful buildings in the city. Persist the postcards (pic. 1.2), published before 1901, which are eloquently evidencing that the Passage became the pearl of the Odessa. Pictures taken before the fire in 1901, as there a central tower on the roof. In the result of the fire, this tower on the roof was



burnt and was not restored.



**Pic.1. «The building of the "Passage" on postcards until 1901»**



**Pic. 2. «General view of the "Passage" building in the early 19th century»**

On the building have a large number of sculptures and stucco (pic. 3-4), the main of them sculpture of Mercury protector of the trade and two sculpture of Fortune. Talented Polish architect L.L. Vlodok balanced harmoniously combined several architectural styles: modernized eclecticism, mixed style of Baroque and Renaissance, eclecticism and late modernity (interiors) and even the Moorish style (arches). At the time of commissioning, "Passage" was equipped with the most modern standards for that time - electric lighting, which was provided by own power station, steam heating, telephones, elevator.

The inner courtyard of the hotel is closed by glass roof and creates a unique atmosphere of the European city with the refinement of architecture and sculptural compositions, inside of the hotel there is a whole street with shopping rows (pic.4)

Before the revolution in "Passage" were the most solid shops of the city: jewelry, perfume and haberdashery, gramophones and musical instruments, gastronomic, crockery, book and postcards. Besides, "Court Passage" Passage" was in the building of "Passage".



**Pic 3.** «Opened cracks on the facade of the "Passage"»



**Pic.4.** «The modern view of the gallery "Passage"»

In the years of the NEP, apart from the hotel and shops, the building housed various Soviet institutions. One of the most famous and the longest (about 100 years) that existed without changing the profile of the "Passage" element was the "Central Gastronome" (located in the premise on the first floor at the corner of Deribasovskaya and Preobrazhenskaya streets). The profile of the retail space store was changed only at the beginning of the 21st century. Nowadays, there is jewellery store and located in the hotel complex and shopping rows.



**Pic.5. «Sculptural groups symbolizing abundance»**

**Основной текст** In 2017, in the old building of the Odessa's "Passage", after reconstruction of water-bearing communications and foundations in 2015, reappeared the cracks. Presumed cause is soaking the loess-like soil of the base of the building and arising due to their uneven precipitation. [3]

The first visual deformation cracks of the "Passage" walls were detected in 2009. By the department of engineering geodesy of Odessa State Academy of Civil Engineering and Architecture on the perimeter of the building were laid deformation sedimentary marks (pic. 6) and were made 4 cycles of high-precision geometric levelling with short beams of sighting by the electronic level DINI 12 according to the program of II class of accuracy. From the analysis of the results, it was concluded that significant local sediments (20-22 mm) of grades 12, 13, 16, 17 are caused by soaking the soil of the foundation of the building from obsolete damaged water-bearing communications, which run from ul. Deribasovskaya through the entrance to the "Passage" After their reconstruction, the fourth leveling cycle showed no further build-up of the building, and a mathematical-statistical analysis of the results confirmed that, in the absence of additional aggressive influences, the sediment would end in May 2019, increasing by 1 mm.

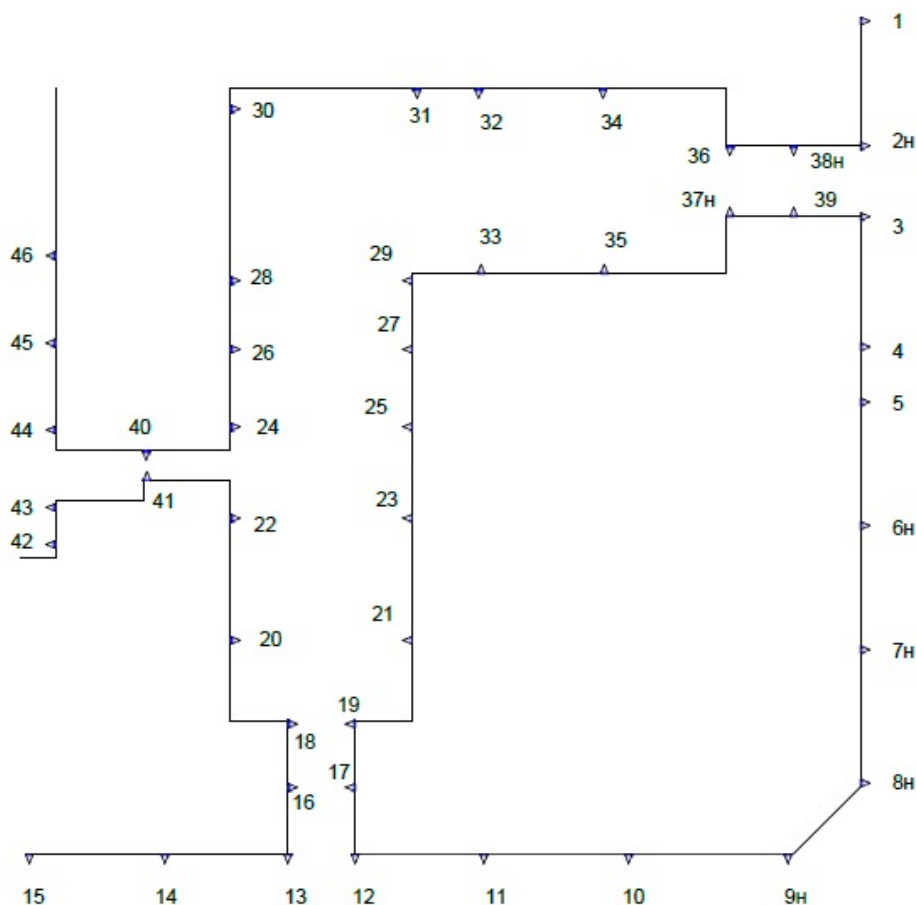
However, in 2016-2017 years the capital reconstruction of the road surface and communications of the street of Preobrazhenskaya with excavation up to 1.5 m (pic. 7-8), which probably influenced condition of the building. [4-7]

For a qualitative assessment of new deformations, finding out their causes, sources, and making recommendations for the elimination of possible disruptions, continued geodetic monitoring performed in 2009-2017.

Geodetic monitoring continued with the observation of sediments of deformation marks and rolls of the exterior walls of the building. The measurement accuracy of the sediment was established in accordance with requirements with an average square error not exceeding  $\pm 2.0$  mm. This value is the starting point for selecting the observation method, the instruments and calculating the accuracy of determining the excess at the station. To determine the building sludge with an average square error of  $m_n \leq \pm 2,0$  mm, the method of high-precision geometric levelling by short beams of



sight up to 25 m was used in accordance with the program of II class of accuracy using the high-precision electronic level DINI 12 and bar-code strip. Three base-points were used as a fixed base. [4-7]



**Pic. 6. «Deformation marks arrangement»**



**Pic. 7. «Reconstruction of the Transfiguration Street in 2017»**



**Pic. 8. «Replacement of engineering networks near the "Passage"»**

From the obtained results it follows that from August 26, 2017 to 07.03.18 the building sludge was practically absent with the exception of grades 12, 13, 16, 17, 18, 19 from 3 to 9 mm, M37 and M38 - 12 mm and M29 - 30 mm. There are no regularities in the development of precipitation, except that the first two grades are in the sensitive structures of the building-arches, and the M29 sediment is probably associated with reinforced concreting to strengthen the foundations of the "Passage's" interior with the use of jackhammers in conjunction with existing foundations.

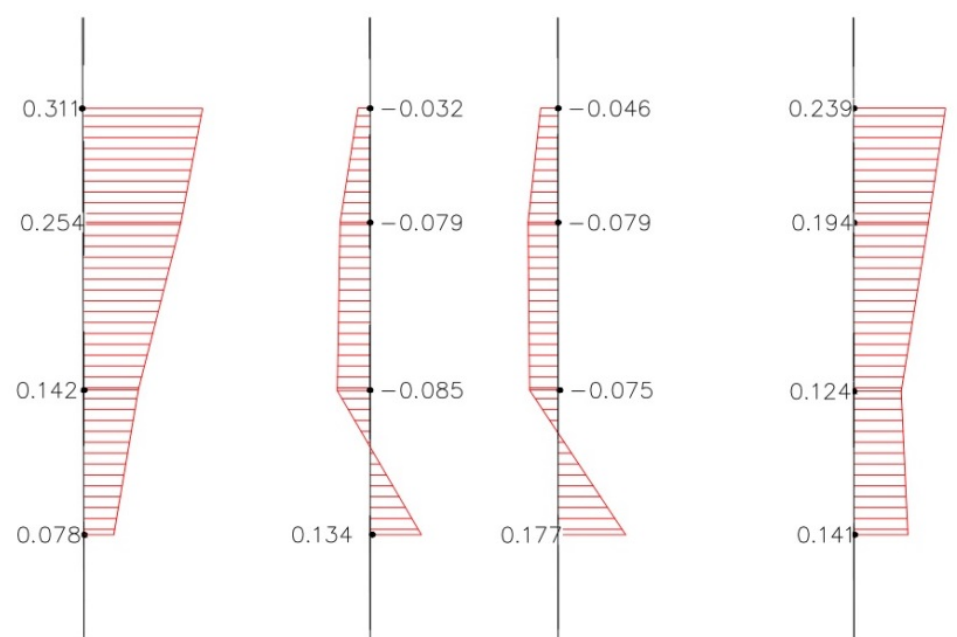
Building tilt were measured instrumental by electronic tachymeter series Nivo. The rolls of the walls were calculated by the coordinate method. The technical task was to determine the roll of the walls of the main facades from the Deribasovskaya street and Preobrazhenskaya street.

In connection with a significant number of architectural elements, the challenge was to the determine the plane of the walls in terms of both height and height. The definition of roll of the building was carried out in height and in four levels. Due to the lack of measurement drawings, the distance between points along the length of the building was taken in such a way that the plane of the wall was designated.

From the results obtained, it follows that the deviation of the walls from the side of Deribasovskaya ranges from 0 to 125 mm. At the same time, there are no regularities in the deviation of the building walls. The maximum deviation of the wall along the vertical is 125 mm. A significant variation in the deviation of the walls in the planned position takes place along the facade from the side of the Preobrazhenskaya Street. The deviation of the wall varies from 0 to 311 mm in the level of the fourth floor. Part of vertical deviations the middle of the building wall from the Preobrazhenskaya street in pictures 9.

### **Conclusions and recommendations.**

1. Precipitation of the building during the last cycle of geodetic observations in the period from 26.08.2017 to 07.03.2018. develops unevenly and is the range from 0 to 30 mm. There is no possibility to establish the reasons for the development of the uneven deformation of the "Passage" building. At the time, the development of uneven deformation can be influenced by:



**Pic. 9. «Part of vertical deviations the middle of the building wall from the Preobrazhenskaya street»**

- change in groundwater level including under the influence of reconstruction of the street of Preobrazhenskaya;

- the impact of technogenic dynamic processes;

- the influence of dynamic processes in the process of reinforcing foundations.

2. Due to the fact that the interval between the penultimate and the last cycles of geodetic measurements is 6 months, it is not possible to establish the development of deformation in time. In this regard, and it is necessary to perform at least three more cycles of geodetic measurements with an interval of 1 month, in order to reveal the regularity in the development of the draft of the building in time.

3. The maximum deviation of the roll from the side of the Preobrazhenskaya Street is 311 mm. In addition, the value of the roll is within the limits permitted by regulatory documents.

4. It is advisable to install deformation marks inside of the building as an arch and as an along the perimeter of the exterior wall of the building from the east side.

5. The building of the "Passage" requires constant geodetic monitoring during the whole period of its reconstruction.

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**Аннотация.** В условиях возрастающего антропогенного воздействия на литосферу, как основания инженерных сооружений, замачивания грунтов из поврежденных изношенных водонесущих коммуникаций, непредсказуемого изменения режима грунтовых вод, попадания в них размывающих агрессивных примесей, образования подземных пустот - первостепенное значение имеет количественная оценка пространственно - временного положения здания, полученная объективными геодезическими методами натурных наблюдений. В самом центре города Одессы на пересечении улиц Дерибасовской и Преображенской расположен памятник архитектуры XIX столетия «Пассаж». В силу изменяющихся техногенных и природных факторов здание «Пассажа» постоянно претерпевало незначительные деформации. Однако, с 2009 года интенсивность деформации здания увеличилась. Для изучения деформационных процессов был организован геодезический мониторинг по исследованию осадки здания. Работы выполняла научно-исследовательская лаборатория кафедры инженерной геодезии Одесской государственной академии строительства и архитектуры. Для количественной оценки осадок здания «Пассажа» был применен метод высокоточного геометрического нивелирования короткими до 25 метров лучами визирования по программе II класса прецизионным электронным нивелиром Dini 12 и штрих - кодовой рейки. Анализ результатов наблюдений послужил основанием для объективного выявления предполагаемых причин осадок. Основной причиной возникших деформаций послужило локальное замачивание грунтов основания здания в результате вытекания воды из поврежденных (испорченных) водонесущих коммуникаций, которые проходят с ул. Дерибасовской через вход в «Пассаж». После реконструкции водонесущих коммуникаций деформационные процессы прекратились. Это позволило дать рекомендации по устранению этих причин и обеспечению в дальнейшем нормальной эксплуатации здания. Во время реконструкции ул. Преображенской в 2017 году, было демонтировано дорожное покрытие на глубину 1-1,5 м, а работы выполнялись тяжелой дорожной техникой и отбойными молотками. Одновременно было начато армированное бетонирование по усилению фундаментов внутренних помещений «Пассажа», также с применением отбойных молотков при связке с существующими фундаментами. Появление новых трещин предположительно является следствием этих вибрационных процессов. Последние наблюдения за осадками здания, выполненные в марте 2018 года, обнаружили дискретные оседания до 12-30 мм за почти полугодовой период. Одновременно измеряли электронным тахеометром Nivo крен наружных стен главных фасадов здания. Вычисление кренов производилось методом координат. Крен в сторону ул. Преображенской достигает 311 мм.

**Ключевые слова:** водонесущие коммуникации, геодезический мониторинг, геометрическое нивелирование, деформационные процессы, крен, осадки здания.

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