საქართველოს მეცნიერებათა ეროვნული აკადემიის მოამბე, ტ. 13, №3, 2019
BULLETIN OF THE GEORGIAN NATIONAL ACADEMY OF SCIENCES, vol. 13, no. 3, 2019

Structural Mechanics

Replacement and Reconstruction of Monument Status Damaged Buildings with Maximal Maintenance of its Look

Olgha Giorgishvili*, Iuri Salukvadze*, Aleksandre Tatanashvili*, Nika Botchorishvili*

* *Faculty of Construction, Georgian Technical University, LEPI, Tbilisi, Georgia*

(Presented by Academy Member Guram Gabrichidze)

ABSTRACT. Protection of cultural heritage is one of the most important problems facing the society. Nowadays there are a lot of heritage status constructions in hazardous conditions in Georgia and they are invaluable one by themselves. In such situations the decision must be taken whether the rate of damage has gone so far that repair is impossible and to admit the complete destruction of the monument, or the only alternative way is radical renovation and rehabilitation. Unlike ordinary buildings, during the restoration and fortifying process of historical constructions we should always take into consideration the non-heterogeneous structure of the material tissue as well as the uniqueness of the construction. Analysis of the cultural heritage status monuments in Tbilisi shows that damage to construction elements is mainly caused by long-term impacts of atmospheric sediments and especially multiple earthquakes. Their constructions are usually performed by local construction materials. The construction technologies at that time were not enough to arrange the anti-seismic elements which are well-known these days. © *2019 Bull. Georg. Natl. Acad. Sci.*

Key words: cultural heritage monuments, replacement-reconstruction, seismic protection systems, polyurethane

Based on the conditions of the constructions with cultural heritage status in our country, it is very difficult and dangerous to restore and strengthen all damaged buildings using the same methods. That is why there are different suggestions to this issue. However, legislation ignores a lot of suggestions, because it is impossible to ruin down the authenticity of the facade, which causes the greatest problem.

In any developed country, where the historical remnants are taken care with special attention, it is very common case that the internal space of the damaged building is dismantled and the remained façade part is adapted to the new, project building, which must be designed to ensure not only the old perimeter wall bearing capacity, but its seismic resistance increasing rate as well. The known options are not perfectly elaborated, since there is an opinion that the joint connecting the main building should be either rigid or jointly [1]. In case of rigid connection, one of the disadvantages of its technical solution is

that the remained façade wall is built by different materials than today's modern constructions, which can be found at about ten meters under the surface of the ground. The most important negative side is the difference in foundation levels and their (foundation) types. Consequently, in case of affect of seismic forces, even if remained wall foundations will be strengthened, it can be occurred an uneven displacement, which will eventually result the failure of the building blocks in the bearing joints. In case of joint connection it may happen even worse result, because the construction is not considered as one whole frame. Both of them are separately impacted by external factors, so the forces caused by an earthquake can cause a resonance when the period of vibrations are coinciding and it causes regrettable result.

Definitely both suggestions have the right of existence, but as we can see, both of them have negative sides in this certain case [2].

In order to ensure long-term exploitation of the facilities it is necessary to involve innovative technologies and active seismic systems. To

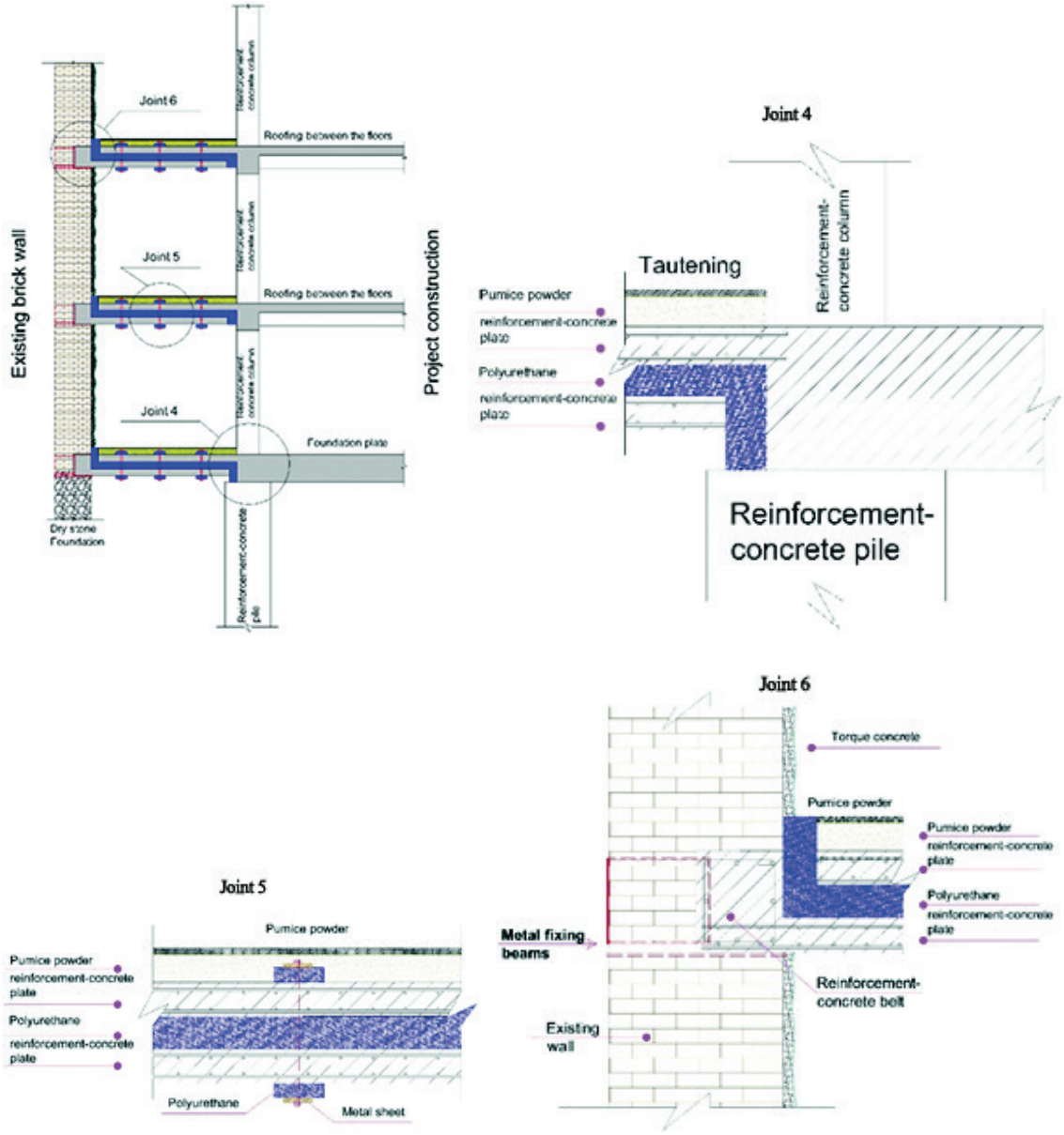

Fig. 1. Connecting of existing wall and designing facilities using horizontal friction connections.

eliminate this problem, it is necessary to connect a connecting diagram that does not transmit static loads on the existing wall and in case of seismic forces, it will ensure the diminishing rate of unwanted vibrations [3].

The new alternate constructive scheme of the connection of the maintained façade wall and carcass building using the horizontal friction connections, and between them it is situated polyurethane mass (Fig. 1) to ensure frictional force.

The reinforcement-concrete belt is arranged in the wall of the retaining perimeter, which itself is fixed by metal chains to the existing wall to provide additional rigidity. Between the walls of project monolithic building on the level of the roof it appears a console tile towards the existing wall, also console tile comes out the reinforcement-concrete belt, and both of them form a single frictional construction. The layer of polyurethane is placed in the gap between the consoles, the upper and lower tiles are pulled taut by the circular spindle metal rods, which have a relatively firm polyurethane sleeper in the zones, while the metal plate (tile) is arranged on the top. The thermal insulation pumice stone is spread on the roof level, and it is pulled. Also it is necessary that one side of the wall (from the inside) should be finished by torque concrete layer of 4-5 cm.

The technical outcome of the suggested constructive scheme is to link old and new buildings in a way that in the case of static loads, the connecting joint should be rigid, and in case of dynamic impacts the joint will work as a joint. The terms of the exploitation of the proposed new type friction construction can be achieved in the order of correctly planning of technological processes. In the beginning, in the process of dismantling, it is necessary to arrange power scaffolds in the maintenance section to avoid additional damage of the construction by mechanical impacts and further maintenance work process. After that, due to a special construction project it is organized a monolithic belt with its own console plate. The crucial role is lain on that the sequence of works, since it is inadmissible to carry out the above mentioned work at all floors level. Works are proceeding from the bottom floor step by step to avoid overloading of construction. At the same time, construction works of the project building are also carried out. As it was mentioned the upper floors connection to the maintained façade wall is carried out only when the lower floors are fully attached, when the polyurethane mass is between the consoles, and they are tautened by the metal rod by tautening the bolts on them. So it continues up to the roof level. For roof constructions it is necessary to arrange seam separation at the joint connection of the old and new parts, or to connect construction in the joint way. It is inadmissible to make them rigid.

There are three theoretically possible options for connecting the existing façade wall and the new structure: 1.Without a connection; 2. Rigid connection; 3. Non-rigid (flexible) connection [4]. The first variant (without connection) is practically unacceptable, since the seismic impact of a single bridge over the brick wall will cause a huge stretching tensions, causing the damage of the wall and possibly destruction as well. For the purpose of finding out which other two options may be given a preference, the calculations were held using the computational complex "LIRA SAPR-2016" (Fig. 2).

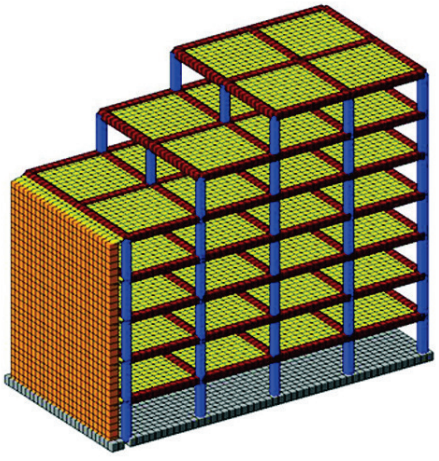

Fig. 2. Calculation model.

Table. Comparison of the received results of reports

#	Feature Settings	Rigid Joining	Frictional Joining	Difference, %
1	Maximum movement of brick wall, mm	24.2	25.2	3.97
2	Maximum stretching tension in brick wall, kg/cm^2	2.94	2.63	10.54
3	Maximum decisive force in the brick wall, ton	4.53	4.06	10.37
4	Maximum bending momentum in the brick wall, T.M.	7.22	5.7	21.05

Rigidity, loading and boundary conditions are identical in both versions. The only connecting joint model is different: in the first case it is rigid and in the second case it is non-rigid (analogue of the friction connection).

Analyzing the results of calculation of the two versions we have evaluated criteria: 1. Maximum horizontal movement of brick wall during seismic impacts; 2. Maximum stretching tension in the brick wall during seismic impact; 3. Maximum decisive force in the brick wall during seismic impacts; 4. Maximum bending momentum in the brick wall during seismic impacts.

All experiments are financially supported by Shota Rustaveli National Science Foundation of Georgia. Study of Properties of Concretes (Both Ordinary and Compacted) Made of Local Building Materials and Containing Admixtures, and Their Further Introduction in Construction Operations and Road Building. Grant №DP2016_26. 22.12.2016

სამშენებლო მექანიკა

ძეგლის სტატუსის მქონე ავარიული ნაგებობების ჩანაცვლება-რეკონსტრუქცია იერსახის მაქსიმალური შენარჩუნებით

ო. გიორგიშვილი*, ი. სალუქვაძე*, ა. თათანაშვილი*, ნ. ბოჭორიშვილი*

*საქართველოს ტექნიკური უნივერსიტეტი, სამშენებლო ფაკულტეტი, თბილისი, საქართველო

(წარმოდგენილია აკადემიის წევრის გ. გაბრიჩიძის მიერ)

კულტურული მემკვიდრეობის დაცვა ერთ-ერთი ყველაზე მნიშვნელოვანი პრობლემაა, რომელიც დგას საზოგადოების წინაშე. დღესდღეობით უამრავი ძეგლის სტატუსის მქონე ნაგებობაა საქართველოში ავარიული, რომელთა ღირებულება ფასდაუდებელია. ასეთ ვითარებაში ჩნდება კითხვა, არის თუ არა დაზიანება იმდენად შორსწასული, რომ შეკეთება უკვე შეუძლებელია; უნდა ვაღიაროთ თუ არა ძეგლის სრული განადგურება; თუ ერთადერთი ალტერნატივა რადიკალური განახლება და რეაბილიტაციაა. ჩვეულებრივი შენობებისაგან განსხვავებით, ისტორიული ნაგებობების აღდგენა-გაძლიერებისას ყოველთვის უნდა ვითვალისწინებდეთ როგორც ნივთიერი ქსოვილის არაერთგვაროვნებას, ასევე კონსტრუქციის უნიკალურობას. თბილისში არსებული კულტურული მემკვიდრეობის ძეგლის სტატუსის მატარებელი ნაგებობების მდგომარეობის ანალიზი გვიჩვენებს, რომ კონსტრუქციული ელემენტების დაზიანება ძირითადად გამოწვეულია მათზე ატმოსფერული ნალექების ხანგრძლივი ზემოქმედებით და განსაკუთრებით მრავალჯერადი მიწისძვრებით. მათი კონსტრუქციები, როგორც წესი, შესრულებულია ადგილობრივი სამშენებლო მასალებით. იმდროინდელი სამშენებლო ტექნოლოგიები არ იყო საკმარისი, დღეს კარგად ცნობილი ანტისეისმური ელემენტების მოსაწყობად.

REFERENCES

1. Baikov V. N., Sigalov E.E. (1991) Zhelezobetonnye konstruktsii. Obshchii kurs, M. (in Russian).
2. Zhunusov T. Zh. (1990) Osnovy seismostoikosti sooruzhenii (Prikladnoi kurs) Alma-ata „Raun“ (in Russian).
3. Lebanidze A., Marjanishvili M. (1996) The study of the problems connected with the vibration of the multistory building built on the portal frame by the use of the seismic platform. The 11th World Conference on Earthquake Engineering. Acapulco, Mexico.
4. Tamura Y., Kousaka R., Modi V.J. (1992) Practical application of nutation damper for suppressing wind-induced vibration of airport towers. *Journal of Wind Engineering and Industrial Aerodynamics.* **73,** 1-3: 1919-1930.

Received February, 2019