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# FIELD TESTS OF THE EXPERIMENTAL CONSTRUCTIVE SCHEMES OF SOUND INSULATION OF THE FLOOR

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**Abstract.** The dynamic development of urbanization in Ukraine, as well as throughout the world, only increases the number of noise sources that disturb people. And this cannot be ignored, because insufficient sound insulation in an apartment threatens people with neuroses, changes in biorhythms, disorders of the digestive system, headache, memory impairment, problems associated with the perception of color. Therefore, you need to pay maximum attention to the sound insulation of premises during the construction of residential buildings.

One of the main disadvantages of monolithic reinforced concrete multi-story buildings is noise. Penetrating into the apartment, he becomes the cause of irritation, an obstacle to sleep or concentrated work. It's no secret that high-quality soundproofing of premises plays an important role in our life and is necessary for our comfortable well-being.

This article is devoted to solving an important issue of soundproofing floors in monolithic reinforced concrete multi-story residential buildings, namely from impact noise. The article discusses structural and technological schemes for sound insulation of a floor of three types, using various materials and their combinations to achieve the regulatory requirements for sound insulation from impact noise.

When choosing the most rational structural and technological scheme, the results of a comparative analysis of organizational and technological indicators for the device of soundproofing the floor were used, as well as indicators of the reduced impact noise obtained as a result of full-scale tests.

Full-scale tests were carried out in houses under construction. The technology for performing each type of floor will depend on the chosen structural and technological scheme, and in the future, the comfort of the residents of the apartment. Comparison of the structural and technological schemes in the future will allow to study and develop a modern and highly efficient structural and technological scheme of the floor sound insulation structure.

**Keywords:** sound insulation, impact noise, multilayer system.

**Introduction.** Constant noise, sounds, conversations of neighbors, loud music can not only irritate, but also affect not only the psychological state of a person, but also the physical one. So that future residents of apartments do not have problems with the nervous system, stress and lack of sleep, when designing buildings, one must seriously consider the development of constructive and technological schemes for soundproofing the floor, as well as their verification and evaluation, which is what this work is devoted to.

**Analysis of recent research.** One of the main disadvantages of high-rise buildings is noise. Both street and from neighbors in the house. Penetrating into the apartment, it becomes a cause of irritation, a hindrance to sleep or concentrated work.

There are two main types of noise: airborne and structural. The medium of distribution of the first is air, the second – a solid body. Airborne noise includes, for example, the conversation of people in the next room or a working TV. Structural noise can be caused by furniture moving on the floor or the sound of a hammer and is one of its most unpleasant types – percussion, which can be

heard even at a considerable distance from the source (the strikes on the central heating battery on the first floor of the house will surely be heard by residents on the seventh).

If the level of airborne noise insulation by an inter-floor ceiling is determined primarily by the massiveness and thickness of the floor slab, then with regard to impact noise insulation, the problem is always solved by additional structures.

The most important and most effective way to increase impact sound insulation, from the point of view of building acoustics, is the construction of a "floating" floor structure.

In the general case, a floating floor is a massive screed made of concrete or a cement-sand mixture laid on an inter-floor ceiling over a layer of elastic material. The floating floor screed should not have any rigid connections with the enclosing structures, therefore it is separated from the side surfaces of the walls and partitions with elastic gaskets (damper tape). As a material of the insulating layer, as a rule, slabs of acoustic mineral wool on a basalt or fiberglass base or various foamed polymeric roll materials are used.

The sound insulation of a floating floor depends on the massiveness of the screed and the elastic properties of the gasket material and, as a rule, is $\Delta L_{n,w}$ = 23-28 dB. In some cases, the use of highly effective soundproofing materials can achieve a reduction in impact noise by more than 40 dB.

Most often, in economy and comfort class housing, soundproofing is not provided. In most cases, developers use a little-known characteristic as a bonus for investors, since it is not enshrined in building codes and does not affect the cost per square meter. High-quality and effective sound insulation is required except for luxury real estate, since buyers' requirements for such premises are much higher than those who buy budget housing. In low-cost new residential complexes and old houses, residents have to independently carry out repairs that will help get rid of noise [1-3]. But, at the construction stage, the likelihood of poor-quality or incorrect soundproofing is much less. Therefore, the complex implementation of work on the installation of soundproof floors simplifies the creation of comfortable conditions for future residents of the apartment [4-6]. There are the following types of noise: air – any sound vibrations transmitted through the air. Human conversation, screams, the noise of cars or animals outside the window. All these sounds come to us through cracks, doors and windows. The impact is the noise that penetrates into our apartments up to the ceilings. Often we can hear neighbors' repairs very well and all the construction tools that are being used at the same time. This kind of noise is probably the most annoying. Structural – this is the name of vibration noise [7, 8]. It is often mistaken for percussion. It is also transmitted along the walls from the work of construction tools. The first and main obstacle to extraneous noise in an apartment building are the walls and ceiling. And if they do not have good soundproofing properties, then residents can hear impact noise from the repair of any apartment even in the next entrance. It is known that protection from airborne noise depends on the load-bearing structures of the building, that is, on the thickness of the floor and walls, and impact noise depends on a special multi-layer structure of the ceiling made of selected materials [9, 10].

**The purpose and objectives of the work** is to evaluate the effectiveness of structural and technological schemes for soundproofing the floor. To achieve the goal, the following tasks were performed: 1) full-scale tests of floor structures were carried out; 2) the influence of the selected materials on the soundproofing properties of the floor structure was investigated; 3) an evaluation analysis of the organizational and technological solutions of the selected materials for the installation of the floor was carried out.

For this purpose, materials and structural-technological schemes were selected for their construction, as well as a comparative assessment.

**Materials and research methods.** The required level of airborne sound insulation is achieved due to the design of the ceiling itself, which is achieved by a 180 mm thick reinforced concrete monolithic ceiling. For isolation from impact and structural noise, it is necessary to carry out special and more effective design and technological schemes for soundproofing the floor.

The experiments were carried out in natural conditions in apartments of built houses, in six apartments. Type 1 and type 2 structures between the fourth and third floors, type 3 structures

between the fourth and fifth floors. For each type of floor soundproofing construction, two apartments are allocated, for the expediency of obtaining results and eliminating the error factor when performing work [5, 6]. Structural and technological floor soundproofing schemes are developed on the basis of the following materials:

– "Izolkap Fine" (polystyrene concrete with filler "Polyterm Fine") – a light dry mix for the installation of heat and sound insulating screed, belonging to the class of lightweight concrete. The mixture consists of cement and filler – inert expanded polystyrene granules (Ø 2-4 mm), with high thermal insulation capacity, treated with a special additive, which helps to obtain a homogeneous mixture, convenient when working with pumps and uniform distribution of the solution.

– Akuflex roll material based on specially processed polyester fibers, developed in accordance with modern requirements for room acoustics and working to absorb impact noise. The material is used as a soundproof base in floating floor structures, which are a layer between the screed and the floor finish (linoleum, laminate, parquet). In addition, Akuflex can serve as an elastic layer under the screed for additional insulation against impact noise.

– The soundproofing leveling coating "Expanded polystyrene granules on an elastic binder" is a ready-to-use granular mixture (granules Ø 6-8 mm) of an elastic vibration-proofing material, which, after being applied to the floor surface, serves as a soundproofing strip between the screed and the ceiling when installing floating floors.

Thus, the following structural and technological schemes of the floor were arranged, namely: Type 1 (56 mm – screed M 150, 4 mm – Akuflex lining, 20 mm – Izolkap Fine (polystyrene concrete with Polyterm Fine filler), 180 mm – reinforced concrete plate), the scheme is shown in Fig.1.

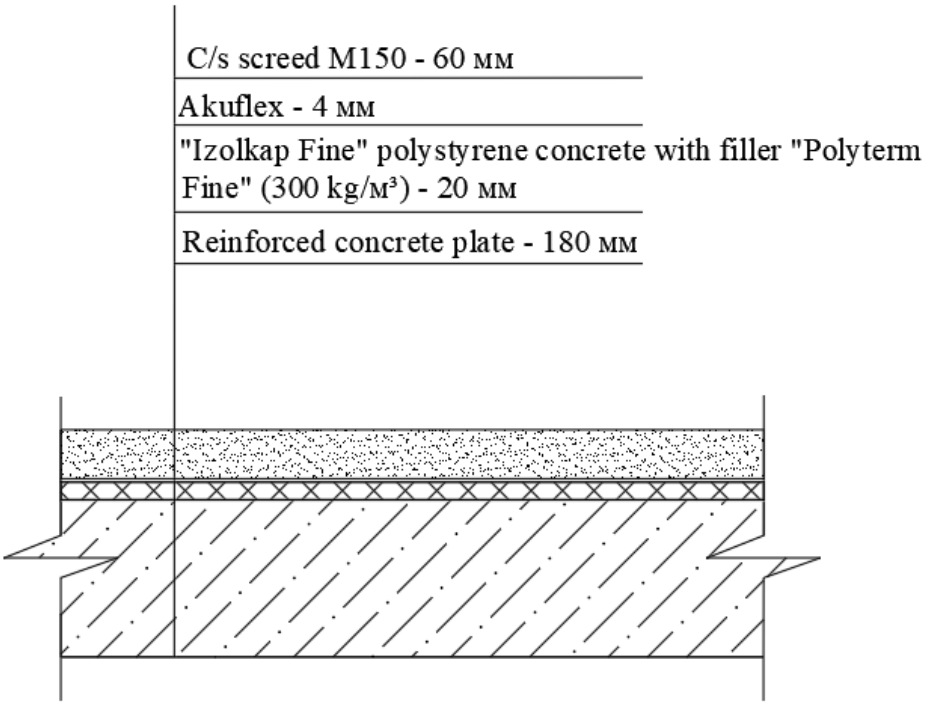


Fig. 1. Floor construction Type 1

Type 2 (60 mm – c/p screed M 150, 20 mm – "Polystyrene foam granules on a rigid binder", 180 mm – reinforced concrete plate), Fig. 2.

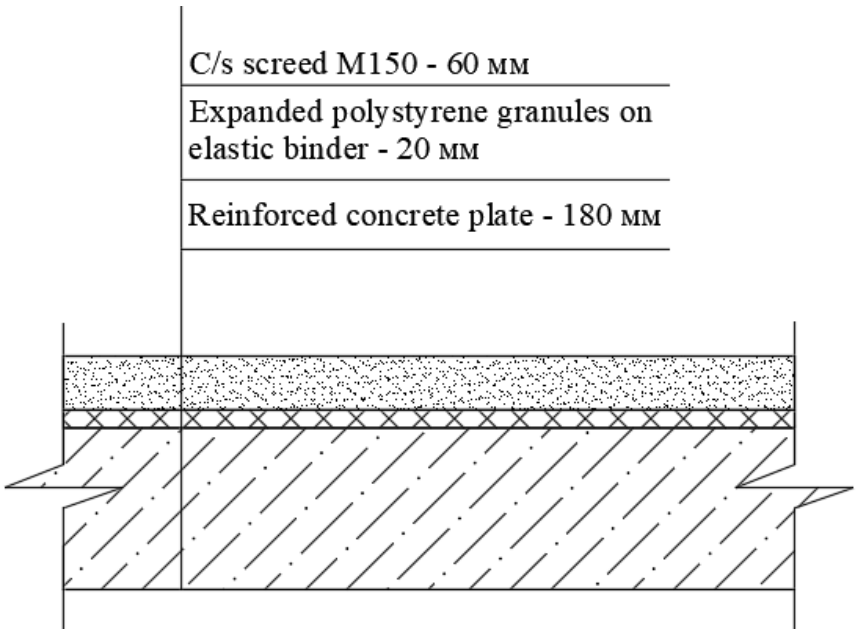


Fig. 2. Floor construction Type 2

Type 3 (80 mm – c/p screed M150, 4 mm – Akuflex substrate, 180 mm – reinforced concrete slab), Fig. 3.

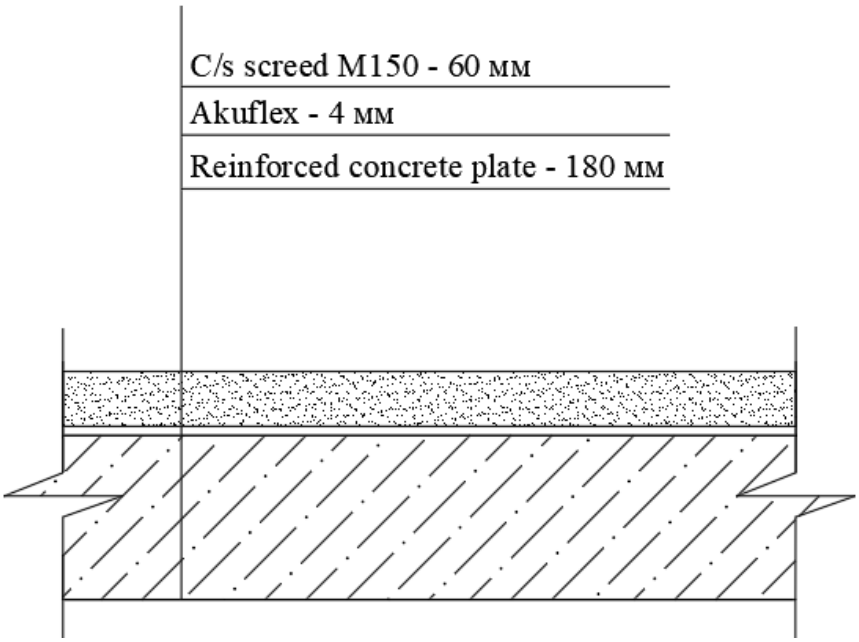


Fig. 3. Floor construction Type 3

*Research equipment.* According to DBN V.1.1-31:2013 "Protection of territories, buildings and structures from noise", the floor must have an airborne sound insulation index – Rw ≥ 52 dB, which is achieved by a monolithic reinforced concrete floor 180 mm thick, and a reduced impact noise index under a canopy – Lnw ≤ 55 dB. For acoustic studies, the following set of measuring equipment was used:

- Acoustic multifunctional counter "Octava-ECOPHYSICS";
- Standard percussion machine "UM-10";
- Microphone dBx;
- Software package for measurement of reverberation time based on PC;
- Preamp P200;
- Acoustic system dB Technologies OPERA 605D.

Impact noise insulation was measured according to the methods of DSTU B V.2.6-86:2009 "Structures of buildings and structures. Sound insulation of enclosing structures. Measurement methods", calculation according to DSTU B V.2.6-85:2009 "Structures of buildings and structures. Sound insulation of enclosing structures. Evaluation Methods".

**Research results.** The results of field studies are shown in Table 1. Type 1 floor construction is compliant, Type 2 and Type 3 floor constructions are non-compliant.

Table 1 – Indications of the reduced impact noise of floor structures, during field tests

| № | Floor construction | Room | L'nw. Reduced impact noise index. Required value L'nw ≤55 dB |
|---|---|---|---|
| **TYPE 1** | | | |
| 1 | – 56 mm c/s screed M150<br>– 4 mm "Akuflex"<br>– 20 mm "Izolkap Fine" (300 kg/m$^3$)<br>– 180 mm reinforced concrete plate | From the 4th to the 3rd floor apartment 1 | 50 |
| 2 | – 56 mm c/s screed M150<br>– 4 mm "Akuflex"<br>– 20 mm "Izolkap Fine" (300 kg/m$^3$)<br>– 180 mm reinforced concrete plate | From the 4th to the 3rd floor apartment 2 | 51 |
| **TYPE 2** | | | |
| 3 | – 60 mm c/s screed M150<br>– 20 mm "Expanded polystyrene granules on an elastic binder"<br>– 180 mm reinforced concrete plate | From the 4th to the 3rd floor apartment 3 | 63 |
| 4 | – 60 mm c/s screed M150<br>– 20 mm "Expanded polystyrene granules on an elastic binder"<br>– 180 mm reinforced concrete plate | From the 4th to the 3rd floor apartment 4 | 61 |
| **TYPE 3** | | | |
| 5 | – 80 mm c/s screed M150<br>– 4 mm "Akuflex"<br>– 180 mm reinforced concrete plate | From the 4th to the 3rd floor apartment 5 | 60 |
| 6 | – 80 mm c/s screed M150<br>– 4 mm "Akuflex"<br>– 180 mm reinforced concrete plate | From the 4th to the 3rd floor apartment 6 | 60 |

**Conclusions and analysis of results.** Field tests of structures for impact noise made it possible to choose the most rational option. In terms of reduced impact sound Lnw, it was determined that the most effective soundproofing floor structure is Type 1, which is 9.1% less than the regulatory requirements. The device of the constructive-technological scheme of sound insulation of the floor Type 1 allows to reduce the level of the initial (reinforced concrete slab without coating) impact noise in the room by 37.5%.

Type 1 floor soundproofing structures fully comply with regulatory requirements for soundproofing against impacts.

Soundproof structures of floors of the 2nd type do not meet regulatory requirements. Based on the results of visual and tactile analysis of individual fragments of the coating made of expanded polystyrene granules with an elastic binder, it can be said that this material meets the requirements for impact sound insulation – it is elastic and has a thickness of 20 mm. However, the results of measurements of structures in the complex show very low results in terms of impact noise insulation.

Type 3 floor soundproofing construction does not comply with the regulations.

**References**

[1] I.E. Cukernikov, L.A. Tihomirov, E.O. Solomatin, I.P. Saltykov, N.A. Kochkin, "Reshenie zadach stroitel'noj akustiki kak faktora, obespechivayushchego bezopasnost' i komfortnost' prozhivaniya v zdaniyah", *Zhilishchnoe stroitel'stvo*, no. 10, pp. 48-49, 2014.

[2] A.R. Murzakova, U.Sh. Shayakhmetov, K.A. Vasin, V.S. Bakunov, "Razrabotka tehnologyi polucheniya efektivnogo stroitelnogo yacheistogo teplo i zvukoizolyatsionnogo konstrukcionnogo materiala", *Stroitelnye materialy*, no. 5, p. 65-66, 2011.

[3] DBN V.1.1-31:2013. "Zahist terutoriy, budivel' ta sporud vid shumu". Kiïv, Ministerstvo regional'nogo rozvitku, budivnictva ta zhitlovo-komunal'nogo gospodarstva Ukraïni, 2014.

[4] V.L. Angelov, L.V. Angelov, "Zvukoizolyatsiya mezhetazhnikh perekrytiy sovremennykh krupnopanel'nykh zdaniy", *Materialy mezhdunarodnoy nauchno-prakticheskoy konferencii "Energosberezhenie i ekologiya v stroitelstve i ZhKKh, transportnaya i promyshlennaya tekhnologiya*". Moskva-Budva, 2010, p. 195-197.

[5] DSTU B V.2.7-183:2009. Stroitel'nie materialy. Materialy i izdeliya stoitel'nie zvukopogloschaushchie i zvukoizolyatsionnie. Klasifikatsiya I obchie tekhnicheskie trebovaniya. Kiïv, Minregionbud Ukraïni, 2010.

[6] A.S. Polevshchikov, "Zvukoizolyatsiya mezhetazhnikh perekritiy v zhilikh zdaniyakh", *Zhilishchnoe stroitel'stvo*, no. 7. pp. 55-57, 2015.

[7] A.I. Gerasimov, E.V. Nikonova, "Zvukoizolyatsiya akusticheski onorodnim perekritiem s rulonnymi materialamy", *Materialy mezhdunarodnoy nauchno-prakticheskoy konferencii "Problemy ekologicheskoy bezopasnosti i energosberezheniya v stroitelstve i ZhKKh"*, Moskva-Kavala, p. 173-177, 2014.

[8] V.A. Gorin, V.V. Klimenko, E.P. Shnurnikova, "Izolyatsiya udarnogo shuma mezhetazhnimy perekritiyami s parketnimy polamy", *Academia. Arkhitectura i stroitelstvo*, no. 3, pp. 200-203, 2010.

[9] DSTU-N B V.1.1-34:2013. "Postanovleniye po raschetu i proektirovaniyu zvukoizolyatsii ograzhdayuschikh konstruktsiy zhulikh I obschestvennikh zdaniy", 2014.

[10] V.S. Didkovsky, V.P. Hare, N.A. Samoylenko, "Ocenka izolyatsii vozdushnogo shuma ograzhdayuschikh konstruktsiy v rasshirennom diapazone chastot", *Electronika i svyaz'*, no. 1, pp. 164-168, 2011.

## НАТУРНІ ДОСЛІДИ ЕКСПЕРИМЕНТАЛЬНИХ КОНСТРУКТИВНИХ СХЕМ ЗВУКОІЗОЛЯЦІЇ ПІДЛОГИ

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**Анотація.** Динамічний розвиток урбанізації в Україні, як і в усьому світі, тільки збільшує кількість джерел шуму, які заважають людям. І це не можна залишити без уваги, адже недостатня звукоізоляція в квартирі загрожує людям неврозами, змінами біоритмів, порушеннями травної системи, головним болем, погіршенням пам'яті, проблемами, пов'язаними зі сприйняттям кольору. Через це потрібно приділяти максимум уваги під час будівництва житлових будинків до звукоізоляції приміщень.

Один з головних недоліків монолітних залізобетонних багатоповерхових будинків – шум. Проникаючи в квартиру, він стає причиною подразнення, перешкодою сну або зосередженої роботи. Ні для кого не секрет, що якісна звукоізоляція приміщень відіграє важливу роль в нашому житті і необхідна для нашого комфортного самопочуття.

Дана стаття присвячена вирішенню важливого питання, по звукоізоляції підлог в

монолітних залізобетонних багатоповерхових житлових будинках, а саме від ударного шуму. У статті розглянуті конструктивно-технологічні схеми звукоізоляції підлоги трьох типів, з використанням різних матеріалів і їх комбінацій для досягнення нормативних вимог звукоізоляції від ударного шуму.

При виборі найбільш раціональної конструктивно-технологічної схеми використовувалися результати порівняльного аналізу організаційно-технологічних показників при влаштуванні звукоізоляції підлоги, а також показники приведеного ударного шуму, отриманих в результаті проведення натурних випробувань.

Натурні випробування були проведені в будинках, що будуються. Від обраної конструктивно-технологічної схеми буде залежати технологія виконання кожного типу підлоги, а в майбутньому і комфорт мешканців квартири. Порівняння конструктивно-технологічних схем в майбутньому дозволить дослідити і розробити сучасну і високоефективну конструктивно-технологічну схему конструкції звукоізоляції підлоги.

**Ключові слова:** звукоізоляція, ударний шум, багатошарова система.

## НАТУРНЫЕ ИСПЫТАНИЯ ЭКСПЕРИМЕНТАЛЬНЫХ КОНСТРУКТИВНЫХ СХЕМ ЗВУКОИЗОЛЯЦИИ ПОЛА

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**Аннотация.** Динамичное развитие урбанизации в Украине, как и во всем мире, только увеличивает количество источников шума, которые мешают людям. И это нельзя оставить без внимания, ведь недостаточная звукоизоляция в квартире грозит людям неврозами, изменениями биоритмов, нарушениями пищеварительной системы, головной болью, ухудшением памяти, проблемами, связанными с восприятием цвета. Поэтому нужно уделять максимум внимания при строительстве жилых домов к звукоизоляции помещений.

Один из главных недостатков монолитных железобетонных многоэтажных домов – шум. Проникая в квартиру, он становится причиной раздражения, препятствием сна или сосредоточенной работы. Ни для кого не секрет, что качественная звукоизоляция помещений играет важную роль в нашей жизни и необходима для нашего комфортного самочувствия.

Данная статья посвящена решению важного вопроса по звукоизоляции полов в монолитных железобетонных многоэтажных жилых домах, а именно от ударного шума. В статье рассмотрены конструктивно-технологические схемы звукоизоляции пола трёх типов, с использованием различных материалов и их комбинаций для достижения нормативных требований звукоизоляции от ударного шума.

При выборе наиболее рациональной конструктивно-технологической схемы использовались результаты сравнительного анализа организационно-технологических показателей при устройстве звукоизоляции пола, а также показатели приведенного ударного шума, полученных в результате проведения натурных испытаний.

Натурные испытания были проведены в строящихся домах. От выбранной конструктивно-технологической схемы будет зависеть технология выполнения каждого типа пола, а в будущем и комфорт жильцов квартиры. Сравнение конструктивно-технологических схем в будущем позволит исследовать и разработать современную и высокоэффективную конструктивно-технологическую схему конструкции звукоизоляции пола.

**Ключевые слова:** звукоизоляция, ударный шум, многослойная система.

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