



## КЛАСИФІКАЦІЯ БУДІВЕЛЬ ЗА ВИСОТОЮ

**А. М. Югов<sup>1</sup>, А. О. Тимошко<sup>2</sup>**

*Донбаська національна академія будівництва і архітектури,  
2, вул. Державіна, м. Макіївка, Донецька область, Україна, 86123.*

*E-mail: <sup>1</sup> amyrus@mail.ru, <sup>2</sup> tymoshko@mail.ru*

*Отримана 03 червня 2014; прийнята 26 грудня 2014.*

**Анотація.** У статті проведено аналіз сучасного стану питання класифікації будівель за висотою у різних країнах, зокрема у Росії, Білорусії та в Україні. Згідно з результатами аналізу на даний момент в більшості країн немає єдиної думки щодо поділу будівель на класи за висотою. В роботі надана єдина існуюча в Україні класифікація будівель за умовною висотою, що міститься у ДБН В.1.1-7-2002. Виявлено недоліки цієї класифікації та запропоновано нову класифікацію будівель за умовною висотою, що ґрунтується на особливостях конструктивних та об'ємно-планувальних рішень будівель різних висот та повністю орієнтована на українські нормативні документи. Наведено повне обґрунтування прийнятих у новій класифікації критеріїв поділу та зроблено порівняння запропонованої класифікації з існуючою.

**Ключові слова:** класифікація, будівля, умовна висота, критерій поділу, конструктивне рішення.

## КЛАССИФИКАЦИЯ ЗДАНИЙ ПО ВЫСОТЕ

**А. М. Югов<sup>1</sup>, А. А. Тимошко<sup>2</sup>**

*Донбасская национальная академия строительства и архитектуры,  
2, ул. Державина, г. Макеевка, Донецкая область, Украина, 86123.*

*E-mail: <sup>1</sup> amyrus@mail.ru, <sup>2</sup> tymoshko@mail.ru*

*Получена 03 июня 2014; принята 26 декабря 2014.*

**Аннотация.** В статье проведен анализ современного состояния вопроса классификации зданий по высоте в разных странах, в частности в России, Белоруссии и Украине. Согласно результатам анализа на данный момент в большинстве стран нет единого мнения относительно разделения зданий на классы по высоте. В работе представлена единственная существующая в Украине классификация зданий по условной высоте, которая содержится в ДБН В.1.1-7-2002. Выявлены недостатки этой классификации и предложена новая классификация зданий по условной высоте, которая основана на особенностях конструктивных и объемно-планировочных решений зданий различных высот и полностью ориентирована на украинские нормативные документы. Приведено полное обоснование принятых в новой классификации критериев разделения и выполнено сравнение предложенной классификации с существующей.

**Ключевые слова:** классификация, здание, условная высота, критерий разделения, конструктивное решение.

## CLASSIFICATION OF BUILDINGS ON HEIGHT

Anatoliy Yugov<sup>1</sup>, Andrii Tymoshko<sup>2</sup>

*Donbas National Academy of Civil Engineering and Architecture,  
2, Derzhavina Str., Makiyivka, Donetsk Region, Ukraine, 86123.*

*E-mail: <sup>1</sup> amyrus@mail.ru, <sup>2</sup> tymoshko@mail.ru*

*Received 03 June 2014; accepted 26 December 2014.*

**Abstract.** The article analyzes the current state of the question of classification of buildings on height in different countries, particularly in Russia, Belarus and Ukraine. According to the results of this analysis, at this moment in most countries there is no consensus about the division of buildings into classes according to their height. The only existing in Ukraine classification of buildings by conditional height, which is contained in DBN V.1.1-7-2002, is presented in this paper. Disadvantages of this classification have been identified and new classification of buildings by conditional height, which is based on the features of structural and space-planning solutions of buildings with different heights and fully oriented on the Ukrainian normative documents, is proposed. Complete substantiation of adopted in the new classification criteria of division and comparison of proposed classification with the existing have been represented in this paper also.

**Keywords:** classification, building, conditional height, criterion of division, structural solution.

### Formulation of the problem

Construction is the sphere of industry developing the most dynamically. The design methods, structural systems of buildings, erection of buildings processes and building material used for production of building structure have been permanently improved. Thus, the height of buildings and structures is increased in due course reaching new and new symbols.

Once upon a time, when houses were used to be single-storey, there was no their classification problem by the height. But with the technical progress development and appearance of multi-storey buildings, the problem of division of buildings into the various groups came into being. The first versions of classification of the buildings on the height were relatively simple (e.g. single-storey and high-rise ones) because there were not buildings with different singularities. But, as was pointed out, the construction is in progress and in due course high-rise buildings became different on their space and planning conceptions in accordance with applied technical and structural methods used in them, in this connection the height of the given buildings as beforehand was increased rapidly. The initial smelting of pig iron by Abraham Derby in 1720, discovery of a lift in 1864, introduction into action of open-hearth furnace and beginning of steel application in construction in 1864 promoted for development of

high-rising construction that, in its turn, complicated the problem of classification of the buildings by the height. Besides, as E. N. Kodish [1] pointed out, at the end of XIX century the USA constructed new category of buildings – multi-storey construction, that is for the first time the term «high-rising building» was used. This is confirmed by the fact that still in 1883 an architect William la Baron Genny constructed 10-storey building «Home Insurance Building» with height of 55 meters in Chicago was assumed as the first high-rising building. The appearance of new types of buildings and their development demanded not only the improvement of old ones but creation of new more complicated classifications on the height.

That is, generalizing the above mentioned information, one can confirm that it is necessary to classify buildings by the height which is connected with the variety high-rising buildings from the point of view of space-planning and structural peculiarities that preclude the possibilities to refer all the high-rising buildings to some kind of a class.

Nowadays in Ukraine the problems of classification of buildings on the height are rather complicated ones. In spite of the rapid development of constructional sphere and appearance in Ukrainian megalopolises higher buildings, the analysis of the principal normative documents regulating design of different types of buildings: NCR V.1.1-7-2002 [2],

NCR V 2.2-24-2009 [3], NCR V.2.2-15-2005 [4] revealed that at the present moment there is the only classification of buildings by height, exactly by conditional height which is in the NCR V.1.1-7-2002 [2]. The more in-depth analysis of the document discovered that this classification was made merely on the basis of various types of evacuation methods in buildings but civil engineers need classification dividing building on the height on the basis of peculiarities of structural and space and planning conceptions of the buildings but there is no such kind of classification at all in Ukraine.

### The purpose of the paper

The study of the problem of buildings classification on the height in different countries and producing of buildings classification on the height depending on structural singularities of buildings of various height in accordance with regulations of the Ukrainian Construction Rules.

### The analysis of existing classifications

The analysis of the papers by L. A. Viktorova [5], Yu. G. Granik [6], A. Tarantsev [7], V. Kravtsov [8], Yu. I. Potapova [9], I. S. Yermolovich and N. M. Vasilets [10] and also A. M. Asaul and S. M. Ivanov [11] revealed that in spite of the rich world practice of construction of high-rising buildings there is no uniform classification of buildings on the height yet. Besides there are two types of parallel measurement of high-rising buildings – in meters and in storeys or floors. In her paper L. A. Viktorova [5] connects it with peculiarities of different normative documents in dependence on the tasks to solve which are directed the contents one or another document. In this connection, A. Tarantsev, Yu. Potapova and I. Yermolovich in their papers [7, 9, 10] reached the common conclusion that application of the criterion of the height in meters is more correct because the height of storeys in a building can be distinguished from the building purpose and demands of the National Designing Rules.

As was pointed out earlier, nowadays there is no a unified idea how to classify buildings on the height because all the existing classifications are rather conditional and distinct from each other. The first attempt to divide buildings by the given indication was done at the symposium of CMEA in Moscow in

1976. At that time, the common classification of buildings on the height in meters was accepted. In the classification, the buildings higher than 30m were fallen in the category of the high-rise buildings, the buildings up to 50, 75 and 100 meters, respectively, to I, II and III category of high-rising buildings and the buildings higher 100 meters (that is approximately with 30 storeys) to skyscrapers. The fact was represented in the papers of V. Kravtsov [8], A. Tarantsev [7], I. Yermolovich [10] and in the coursebook by V. Shuller [12].

It can be said that the given classification has been still used in Russia in application to public buildings. But the frameworks accepted by CMEA are not rigid, so in many countries the concepts «multistorey», «high-rising» and «high-rise building» are distinguished depending on designing traditions adopted in one or another country.

Concerning the contemporary classification of buildings on the height in Russia, it is rather complicated problem because of the fact that various sources of information give different explanation of the similar terms and as a consequence, different classification of buildings. For instance, A. M. Asaul in his paper [11] refers buildings with height up to 3 storeys to low-rise ones, with height of 4–9 storeys to high-rise buildings, with height of 10–20 storeys to multistorey buildings and buildings higher than 20 storeys as skyscrapers.

A. Tarantsev [7] gives the similar classification but he refers to low-rise buildings that are higher than 1–2 storeys and to high-rise buildings that are higher than 16 storeys.

It should be pointed out that in spite of all disadvantages of the classification of buildings on the number of storeys, residential buildings in Russia are accepted to be classified namely by this criterion. Total analysis of classification of buildings in Russia was also made in the papers of I. Yermolovich and N. Vasilets [10]. They state that starting from the fire-protection requirements and requirements of normative documents, such as MESR 4.19-2005 «Temporary rules of designing of multi-functional high-rise buildings and complex buildings in Moscow» [13] and TCR 31-332-2006 «Residential and public high-rising buildings» [14] the practice of reference to high-rising buildings higher than 75 meters (approximately 25 storeys) became customary in Russia. On the basis of the statement, they offer the following classification of the buildings on

the height: low-rise buildings – 1–2 storeys, average-rise buildings – 3–5 storeys, multistorey buildings – 6–10 storeys, high-rise buildings – 11–25 storeys, skyscrapers – more than 25 storeys. L. A. Viktorova, V. Kravtsov and Yu. Potapova hold the same point of view to refer buildings to one or another group in their papers [5, 8, 9]. It should be noticed that in accordance with [15], multistorey buildings relate to the structures more than 10–25 storeys on the territory of Russian Federation and this piece of information practically coincides with above-mentioned classification by I. Yermolovich and N. Valilets.

In other countries, e. g. in Belorussia, there is another classification of the buildings on the height. Belorussian rules TCR 45-3.02-108-2008 «High-rise buildings. Construction rules of designing» [16] has been established that to high-rise buildings are related multistorey buildings with height from 75 to 100 meters and public buildings and buildings of multi-functional assignment with height from 50 to 200 meters. In connection with it, in accordance to point 3.1 of the document, the height of the building is the difference of marks from the surface of roadway of the nearest passageway to the building up to level mark of the upper storey floor not considering maintenance storey. By the way, the similar designation is given in the Ukrainian NCR V.1.1-7-2002 [2] as «a conditional building height».

A. Kravtsov [8] connects height restriction in a residential zone with the fact that 100 m is a low mark above the cities and towns in a country of cloudiness and smog which can bring to the health worsening of people living on the upper floors, that is to progress such diseases like «seasickness» or high altitude sickness. Besides, the standards of the Republic of Belorussia RTC P 2331-2013 «Classification of buildings and structures» [17] relate buildings higher than 30 m.

In the paper of L. A. Viktorova [5], there is the example of classification of buildings on the height in Germany. According to the classification, all the buildings are divided into 4 groups: I. are the buildings with height 22–30 m, II. with height 30–60 m, III. with height over 60 m and IV. with height over 200 m. From this point, one can make a conclusion that there are different concepts concerning high-rising of the buildings in various countries thus, classification of various countries differ between each other countries.

Concerning classification of buildings on the height in Ukraine, as it has been pointed out already, the analysis of the normative documents NCR V.1.1-7-2002 [2], NCR V.2.2-24-2009 [3], NCR V.2.2-15-2005 [4] showed that the uniform acting at the present moment classification have been just given in NCR V.1.1-7-2002 «Fire safety of building objects» [2]. But to the base of classification was laid just criteria of fire safety connected with different ways of evacuation of people from the buildings. Nevertheless, as L. A. Viktorova points out correctly, high-rising of a building depends on largely on its space and planning, structural and other singularities that determined by requirements to resistance and reliability of the structural system of a building. Thus, we are mostly interested by the classification of buildings on the height just from the point of view of structural criteria of division. But, unfortunately, there is no such kind of classification in Ukraine.

NCR V.1.1-7-2002 «Fire safety of building objects» [2] classifies all buildings by the conditional height in the following way:

- a) low-rise buildings – height is  $H \leq 9$  m (as a rule up to 3 storeys including);
- b) multistorey buildings – height is  $9 \text{ m} < H \leq 26.5$  m (as a rule up to 9 storeys including);
- c) high-rise buildings – height is  $26.5 < H \leq 47$  m (as a rule up to 16 storeys);
- d) skyscrapers – height is 47 m (as a rule more than 16 storeys).

In this connection, for conditional height NCR V.1.1-7-2002 [2] takes the height of arrangement of the upper floor without regard to the upper storey for utility services. In turn, the height of arrangement of the upper floor is determined by distinction of marks of the passageway surface for fire engines and floor of the upper storey.

However, more in-depth analysis of the given classification showed that it is composed on the basis of criteria of fire safety of buildings. For instance, point 5.36 of NCR V.1.1-7-2002 [2] determines that in buildings with conditional height of not more than 9 m (low-rise buildings) it is permitted to stipulate staircases of the type SC2 (Staircase 2), the same point points out that in buildings with the conditional height of not more than 26.5 m (multistorey buildings) the staircase of the type SC1 (Staircase 1) is used. The point 5.39 of NCR V.1.1-7-2002 [2] states that in buildings with conditional height

of more than 26.5 m (high-rise buildings) pressurized staircases are stipulated. And, at last, point NCR V.1.1-7-2002 [2] states that in the building with conditional height of more than 47 m (skyscrapers) there should be stipulated lifts or elevators to transport a subdivision of the fire guard. Summing up the above-mentioned information, one can make the conclusion that given in NCR V.1.1-7-2002 [2] classification of the buildings on the height is composed completely on the basis from different ways of evacuation for building of various height.

### Classification of buildings on height and number of storeys

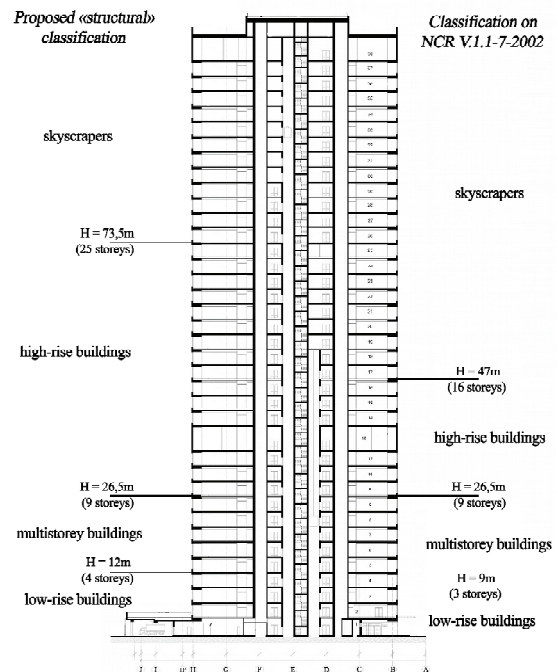
As it was pointed out earlier, we are mostly interested by classification of buildings on the height which would be based on structural singularities of buildings with various height. Thus, according to the purpose of investigation, the classification of buildings on the conditional height was composed that based on just structural criteria of division which are standardized by regulations NCR V.1.1-7-2002 [2], NCR V.2.2-24-2009 [3] and NCR V.2.2-15-2005 [4]. It has the following mode:

- low-rise buildings – height is  $H \leq 12$  m ( as a rule up to 4 storeys including);
- multistorey buildings – height is  $12 \text{ m} < H \leq 26.5$  m (as a rule up to 9 storeys including);
- high-rise buildings – height is  $26.5 < H \leq 73.5$  m (as a rule up to 25 storeys);
- skyscrapers – height is  $H > 73.5$  m (as a rule more than 25 storeys).

The complicated «structural» classification can be also given in the form of comparison with existing «fire hazard classification» (see Figure).

**Note:** since the regulation of ruling documents on the territory of Ukraine NCR V.1.1-7-2002 [2], NCR V.2.2-24-2009 [3], NCR V.2.2-15-2005 [4] is oriented to the conditional height of the buildings (see point 2.18 [2]) so the proposed «structural» classification is also composed in dependence on the conditional height of the buildings. At pointing out of approximate height of buildings of various groups, the average height of the floor of 3 m was used.

In contrast to «fire» classification NCR V.1.1-7-2002, in «structural» classification in the limits between various groups of buildings there are elements that impact to the principal choice of structural or space and planning solution of a building in



**Figure.** Comparison of the proposed «structural» classification of buildings on the height (on the left) and classification of the buildings on NCR V.1.1-7-2002 (on the right).

the whole. The instance for a limit between low-rise ( $<12$  m) and multistorey buildings ( $>12$  m) a lift was accepted, that the buildings without lifts are proposed to relate to low-rise ones. The equipment the buildings with lifts is regulated by the point 5 of NCR V.2.2-15-2005 [4], just the point 5.1 states that in buildings higher of 5 and more (that is  $>12$  m) the lift is installed necessarily. The lift was taken for the limit of classification because the appearance of lift shaft in a building changes its space and planning solution significantly in comparison with buildings without a lift. It should be pointed out that NCR V.2.2-15-2005 [4] represents a term «low-rise building» as construction of the territory with one-, two- or three- storey buildings ( $<9$  m) but in this case it is not completely clear why three storeys are the limit.

For the limit between multistorey buildings ( $<26.5$  m) and high-rise buildings ( $>26.5$  m), as in the «fire» classification [2] pressurized staircases were accepted because their appearance also effect to the choice of the space and planning and structural solution because that to such kind of staircases special requirements introduce concerning their arrangement in a building. In the contrast to classification

on [2], in the proposed «structural» classification pressurized staircases are considered to be as a structural element but not as the way of evacuation. Application of pressurized staircases in the buildings is regulated by point 5.39 of NCR V.1.1-7-2002 [2], which establish that pressurized staircases should be stipulated in the buildings with conditional height more than 26.5 m.

At last, for the limit between high-rise buildings and skyscrapers were accepted the mark of 73.5 m. For the first time in Ukraine the designing of buildings higher than 73.5 m is regulated by the separate document NCR V.2.2-24-2009 «Design of residential and civil skyscrapers» [3] which gives the term «a skyscraper» as «a multistorey building of residential and civil application with conditional height from 73.5 m and higher». Secondly, the buildings higher than 73.5 m require quite another approaches to design in the whole since there are no increased requirements to high-rising buildings concerning resistance and reliability of structural system. The fact is also represented in papers of V. Kravtsov [8] and I. Yermolovich [10]. Besides, Yu. Granik in his paper [6] correctly notes that with increasing of the height of a building the load to load-bearing structures is increased sharply (mainly the dead load and wind load). In connection with it, L. Viktorova in her paper [5] points out that in buildings higher than 75m principally another types of structural sys-

tems are applied (e.g. shaft or box systems) that distinguish them from the buildings of less height.

### Conclusion

The problem of building classification on the height is especially acute in the world. It arose in the XIX century with appearance of skyscrapers and furthermore required permanent study and improvement of existent classification. Nowadays, there are many classifications of buildings on the height which are different between each other via various conceptions concerning the height of buildings in different countries. With respect to classification of building on the height in Ukraine, the analysis of normative documents showed that at the present moment there is only one classification based on foundation of requirements of fire safety of buildings but it is not completely proved from point of view to their structural solutions. In the proposed paper of «structural» classification of buildings the structural singularities of buildings of various height are accepted for criteria of division of buildings to the groups, namely: presence or absence of lifts in pressurized staircases and application of specific structural systems for skyscrapers. This classification solves the problem of absence engineering classification of buildings on the height in Ukraine and can be applied in construction practice to determine a group of any building.

### References

1. Кодыш, Э. Н. Проектирование многоэтажных зданий с железобетонным каркасом [Text] : [монография] / Э. Н. Кодыш, Н. Н. Трекин, И. К. Никитин. – М. : Издательство Ассоциации строительных вузов, 2009. – 352 с. – ISBN 978-5-93093-679-7.
2. ДБН В.1.1-7-2002. Пожежна безпека об'єктів будівництва [Text]. – На заміну СНиП 2.01.02-85\* ; введ. 01.05.2003. – К. : Держбуд України, 2003. – 42 с. – (Державні будівельні норми України).
3. ДБН В.2.2-24:2009. Проектування висотних житлових і громадських будинків [Text]. – Введено вперше ; чинні від 2009–09–01. – К. : Мінрегіонбуд України, 2009. – 133 с. – (Державні будівельні норми України).
4. ДБН В.2.2-15-2005. Житлові будинки. Основні положення [Text]. – На заміну СНиП 2.08.01-89, ДБН 79-92 ; чинні від 2006–01–01. – К. : Держбуд

### References

1. Kodysh, E. N.; Trekin, N. N.; Nikitin, I. K. Designing of multistory buildings, having reinforced concrete frame. Monograph. Moscow: Publishing house of Association of Construction Institutes, 2009. 352 p. ISBN 978-5-93093-679-7. (in Russian)
2. DBN V.1.1-7-2002. Fire safety of civil engineering objects. Kyiv: State Committee for Construction of Ukraine, 2003. 42 p. (in Ukrainian)
3. DBN V.2.2-24:2009. Designing of high-rise apartment and civil buildings. Kyiv: Ministry of Regional Development of Ukraine, 2009. 133 p. (in Ukrainian)
4. DBN V.2.2-15-2005. Apartment buildings. Fundamental. Kyiv: State Committee for Construction of Ukraine, 2005. 36 p. (in Ukrainian)
5. Viktorova, L. A. High-rise buildings – advantages and disadvantages of civil engineering. In: *Architecture*

- України, 2005. – 36 с. – (Державні будівельні норми України).
5. Викторова, Л. А. Высотные здания – плюсы и минусы строительства [Electronic resource] / Л. А. Викторова // Архитектура и строительство России. – 2012. – № 10. – Режим доступа к статье : <http://www.asrmag.ru/article/vysotnye-zdaniya/>. – (Дата обращения 14.03.2014). – Название с экрана.
  6. Граник, Ю. Г. Проектирование и строительство высотных зданий [Electronic resource] / Ю. Г. Граник // Энергосбережение. – М. : ООО ИИП «АВОК-ПРЕСС», 2004. – № 2. – С. 92–97. – Режим доступа к статье : [http://www.abok.ru/for\\_spec/articles.php?nid=2444](http://www.abok.ru/for_spec/articles.php?nid=2444) (Дата обращения 14.03.2014). – Название с экрана.
  7. Таранцев, А. Нормативы берут высоту [Electronic resource] / Александр Таранцев, Станислав Жаров, Андрей Куянов // БДИ : Журнал. – 2005. – № 4(61). – С. 30–34. – Режим доступа к статье : [http://mx1.algoritm.org/61/61\\_Gefest.htm](http://mx1.algoritm.org/61/61_Gefest.htm) (Дата обращения 14.03.2014). – Название с экрана.
  8. Кравцов, В. Высотные здания. Особенности проектирования, строительства и мониторинг фундаментов [Electronic resource] / Владимир Кравцов // Архитектура и строительство. – 2010. – № 1(212). – Режим доступа к статье : <http://ais.by/story/5540> (Дата обращения 14.03.2014). – Название с экрана.
  9. Потапова, Ю. И. Высотное строительство в России – проблемы, задачи и способы их решения [Text] / Ю. И. Потапова // Успехи современного естествознания / гл. ред. М. Ю. Ледванов. – 2012. – № 6. – С. 14–16. – ISSN 1681-7494.
  10. Ермолович, И. С. Обзор строительного рынка жилой недвижимости города Красноярска по этажности зданий [Electronic resource] / И. С. Ермолович, Н. М. Василец // Молодежь и наука : сборник материалов IX Всероссийской научно-технической конференции студентов, аспирантов и молодых ученых с международным участием, посвященной 385-летию со дня основания г. Красноярска / отв. ред. О. А. Краев. – Красноярск : Сибирский федеральный университет, 2013. – Режим доступа к статье : <http://conf.sfu-kras.ru/sites/mn2013/thesis/s096/s096-002.pdf> (Дата обращения: 14.03.2014). – Название с экрана.
  11. Асаул, А. Н. Экономика недвижимости [Text] : [учебник для вузов] / А. Н. Асаул, С. Н. Иванов, М. К. Старовойтов. – 3-е изд., исправл. – СПб. : АНО «ИПЭВ», 2009. – 304 с. – ISBN 978-5-91460-018-8.
  12. Шуллер, В. Конструкции высотных зданий [Text] / В. Шуллер ; пер. с англ. Л. Ш. Килимника ; под ред. Г. А. Казиной. – М. : Стройиздат, 1979. – 248 с.
  13. МГСН 4.19-2005. Временные нормы и правила проектирования многофункциональных высотных зданий и зданий-комплексов в городе Москве [Text]. – Введены впервые ; действуют с момента *and Construction of Russia*, 2012, № 10. Accessed at: <http://www.asrmag.ru/article/vysotnye-zdaniya/>. (in Russian)
  6. Granik, Yu. G. High-rise design and construction. In: *Energy saving*, 2004, № 2, p. 92–97. Accessed at: [http://www.abok.ru/for\\_spec/articles.php?nid=2444](http://www.abok.ru/for_spec/articles.php?nid=2444). (in Russian)
  7. Tarantsev, Aleksandr; Zharov, Stanislav; Kuianov, Andrei. Standards clear the bar. In: *BDI*, 2005, № 4(61), p. 30–34. Accessed at: [http://mx1.algoritm.org/61/61\\_Gefest.htm](http://mx1.algoritm.org/61/61_Gefest.htm). (in Russian)
  8. Kravtsov, V. High-rise buildings. Particularities of designing, civil engineering and monitoring of foundations. In: *Architecture and construction*, 2010, № 1(212). Accessed at: <http://ais.by/story/5540>. (in Russian)
  9. Potapova, Yu. I. High-rise construction in Russia – problems, tasks and methods of solutions. In: *Advances of Modern Natural Sciences / Edited by M. Yu. Ledvanov*, 2012, № 6, p. 14–16. ISSN 1681-7494. (in Russian)
  10. Ermolovich, I. S.; Vasilets, N. M. Review of constructional residential property market of Krasnoyarsk according to number of stories in a building. In: *Youth and science: source book of IXth All-Russian scientific and technical conference of students, postgraduates, young scientists of international participation devoted to perennity from the date of foundation of Krasnoyarsk / Edited by O. A. Kraev*. Krasnoyarsk: Siberian federal university, 2013. Accessed at: <http://conf.sfu-kras.ru/sites/mn2013/thesis/s096/s096-002.pdf>. (in Russian)
  11. Asaul, A. N.; Ivanov, S. N.; Starovoitov, M. K. Real estate economics. 3rd ed., Corrected. St. Petersburg: ANO «IPEV», 2009. 304 p. ISBN 978-5-91460-018-8. (in Russian)
  12. Shuller, V. Construction of high-rise buildings. Moscow: Stroiizdat, 1979. 248 p. (in Russian)
  13. MGSN 4.19-2005. Temporary regulations and design rules of multi-function high-rise buildings and building-complexes in Moscow. Moscow: GUP «NIAC», 2006. 124 p. (in Russian)
  14. TSN 31-332-2006. Residential and social high-rise buildings. St. Petersburg: Government of St. Petersburg, 2006. 59 p. ISBN 5-87897-129-1. (in Russian)
  15. Povzik, Ya. S. Reference book of Manager of Fire Fighting Operations. Moscow: ZAO «SPETS-TEHNIKA», 2004. 361 p. ISBN 5-901018-40-0. (in Russian)
  16. ТКР 45-3.02-108-2008. High-rise buildings. Construction standards of designing. Minsk: The Ministry of Architecture and Construction of Republic of Belarus, 2008. 94 p. (in Russian)
  17. STB P 2331-2013. Classification of buildings and constructions. Fundamental principles. Minsk: Gosstandart, 2013. 5 p. (in Russian)

- опубликования. – М. : ГУП «НИИЦ», 2006. – 124 с. – (Московские городские строительные нормы).
14. ТСН 31-332-2006. Жилые и общественные высотные здания [Text]. – Взамен ТСН 21-304-2003; дата введения 28.04.2006. – СПб.: Правительство Санкт-Петербурга, 2006. – 59 с. – ISBN 5-87897-129-1. – (Территориальные строительные нормы).
  15. Повзик, Я. С. Справочник руководителя тушения пожара [Текст] / Я. С. Повзик. – М. : ЗАО «СПЕЦТЕХНИКА», 2004. – 361 с. – ISBN 5-901018-40-0.
  16. ТКП 45-3.02-108-2008. Высотные здания. Строительные нормы проектирования [Text]. – Дата введения 2008–12–01. – Минск : Министерство архитектуры и строительства Республики Беларусь, 2008. – 94 с.
  17. СТБ П 2331-2013. Классификация зданий и сооружений. Основные положения [Text]. – Дата введения 2013–12–01 ; дата окончания действия 2015–12–01. – Минск : Госстандарт, 2013. – 5 с. – (Предварительный государственный стандарт Республики Беларусь).

**Югов Анатолий Михайлович** – д. т. н., профессор, завідувач кафедри технології і організації будівництва Донбаської національної академії будівництва і архітектури. Член Української асоціації з металевих конструкцій, член Міжнародної асоціації просторових конструкцій, член Української спілки з неруйнівного контролю та технічної діагностики. Наукові інтереси: експлуатаційна надійність будівельних металевих конструкцій, технічна діагностика будівельних конструкцій, технологія і організація монтажу металевих конструкцій, робота металевих конструкцій з урахуванням монтажних станів.

**Тимошко Андрій Олександрович** – аспірант кафедри технології і організації будівництва Донбаської національної академії будівництва і архітектури. Наукові інтереси: напружено-деформований стан висотних будівель з металевих конструкцій з урахуванням монтажних впливів.

**Югов Анатолий Михайлович** – д. т. н., профессор, заведующий кафедрой технологии и организации строительства Донбасской национальной академии строительства и архитектуры. Член Украинской ассоциации по металлическим конструкциям, член Международной ассоциации по пространственным конструкциям, член Украинского общества по неразрушающему контролю и технической диагностике. Научные интересы: эксплуатационная надежность строительных металлических конструкций, техническая диагностика строительных конструкций, технология и организация монтажа металлических конструкций, работа металлических конструкций с учетом монтажных состояний.

**Тимошко Андрей Александрович** – аспирант кафедры технологии и организации строительства Донбасской национальной академии строительства и архитектуры. Научные интересы: напряженно-деформированное состояние высотных зданий из металлических конструкций с учетом монтажных воздействий.

**Yugov Anatoliy** – DSc (Eng.), Professor; Principal of Construction Technology and Management Department, Donbas National Academy of Civil Engineering and Architecture. He is a Member of Ukrainian Association of Metal Construction, Member of the International association of spatial construction, Member of the Ukrainian society under the undestroyed control and technical diagnostics. His research interests include: the reliability of existing metal structures, technical diagnostics of building designs, technology and management of metal structures erection, stress-strain parameters of metal structures accounting actions during execution.

**Tymoshko Andrii** – PhD student, Construction Technology and Management Department, Donbas National Academy of Civil Engineering and Architecture. His research interests include: stress-strain state of high-rise buildings of metal structures accounting actions during execution.