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ТРАНСПОРТНЕ БУДІВНИЦТВО

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OUTLOOKS OF USING DBN B.2.6-161:2017 «WOODEN STRUCTURES» IN DESIGN PRACTICE

Purpose. From 01.02.2018, the new state standards DBN B.2.6-161:2017 were introduced into the wooden structures design practice. They replace the recently prepared codes DBN B.2.6-161:2010, which, in turn, were elaborated to replace the SNiP II-25-80. The author of this publication would like to draw the attention of developers and potential users of the codes DBN B.2.6-161:2017 to the points that are not entirely clear, which at first reading caused him certain difficulties in terms of their practical use. **Methodology**. The practical experience accumulated by the author in the use of normative literature in educational practice, as well as the available experience during laboratory studies with students, made it possible to estimate the recently introduced codes DBN B.2.6-161:2017 from a practical point of view. **Findings.** In general, the new codes, recently introduced into design practice, are progressive both in their content and in terms of their use in construction practice. However, the existing problem areas in these standards, which are considered in this publication, in our opinion, can significantly limit the possibility of their wide practical application. **Originality.** The analysis of recently introduced new standard was carried out by the author of the publication not only in terms of assessing quality requirements and recommendations, but also in terms of the quantitative aspect of the issue. **Practical value.** The author's experience in calculating simple elements and basic types of connections according to the new codes DBN B.2.6-161:2017 indicates that the bearing capacity determined for various cases is lower on average by 1.5 – 3 times than according to the previous codes SNiP II-25-80. From a practical point of view, this revealed discrepancy means that the already constructed structures may require some reinforcement or reconstruction, and new designed structures should have large bearing sections of the elements and, accordingly, large bearing capacity and weight.

Keywords: wooden structures; timber structures; codes; standard; DBN B.2.6-161:2017; DBN B.2.6-161:2010; SNiP II-25-80

Introduction

Recently, a new system of national building codes based on the «State Building Codes» (DBN), which aims to replace the previous system based on the «Construction Standards and Regulations» (SNiP), has been implemented at an accelerated pace. At the same time, unfortunately, the new codes do not always show high quality of their development, thereby can be repeated several times with the introduction of appropriate clarifications, adjustments or even a fundamental change of certain parts of the document.

In some cases, the codes developed in one of the building structure design areas are not entirely consistent, but sometimes even directly contradict the rules of another industry. And by themselves, the new DBNs are not rarely intrinsically controversial and do not fully reflect the state of affairs and the available factual data in a particular area of design. All of this is due to the lack of a single focal point for the development of a national regulatory framework in Ukraine, on the one hand, and the lack of practical testing of building codes before they are put into operation, on the other hand.

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Purpose

It is precisely this situation that is observed in the design of wooden building structures. From 01.02.2018 the new state standards DBN B.2.6-161:2017 have been introduced into the practice of designing such structures [4]. They replace the recently drafted codes DBN B.2.6-161:2010 [5], which in turn were elaborated to replace SNiP II-25-80 [9].

Since, unfortunately, nowadays the tradition of accompanying codes with special comments or explanations in which their «bottlenecks» are further disclosed (such as «Manual» [10]), it only remains to the users to interpret them at their discretion. Therefore, the author of this publication would like to draw the attention of developers and potential users of the codes DBN B.2.6-161:2017 to the points that are not entirely clear, which at first reading caused him certain difficulties in terms of their practical use. This is the main purpose of this publication.

Methodology

The author of this publication for more than 15 years has been teaching the discipline «Wooden and Plastic Structures» for the 5th year students (previously – for specialists, now – for masters) of the specialization (specialty) «Industrial and Civil Engineering». Therefore, the accumulated experience in the use of normative literature in educational practice, as well as the available experience during laboratory studies with students, made it possible to estimate the recently introduced codes DBN B.2.6-161:2017 from a practical point of view.

Findings

The development and implementation of the codes DBN B.2.6-161:2017 was carried out by «V.N. Shimanovsky Ukrainian Institute of Steel Construction» LLC with participation of a number of experts of leading universities of Ukraine, in particular KhNUCEA, Lviv Polytechnic National University, KNUCEA. In the previous codes DBN B.2.6-161:2010 the main developer is the State Enterprise «State Research Institute of Building Structures», as well as specialists of the PSACEA. The codes SNiP II-25-80 were developed by specialists from four research institutions in the late 70's of the 20th century.

Immediately I would like to note that the introduced codes DBN B.2.6-161:2017 by their quality of preparation are much more elaborated and have a much smaller number of complicated issues and clear mistakes than the previously abolished codes DBN B.2.6-161:2010.

In general, the new codes DBN B.2.6-161:2017 support the course to harmonize the domestic and European regulatory framework in the field of construction. They use the terminology and the system of designations of characteristics oriented on Eurocode, such as the codes for designing concrete and reinforced concrete structures DBN B.2.6-98:2009 [3], as well as stone and reinforced masonry structures DBN B.2.6-162:2010 [6], and unlike the standards for the design of steel structures DBN B.2.6-161:2017 [8] and aluminum structures DBN B.2.6-165:2011 [7], which use the traditional domestic system of symbols. However, traditional design approaches typical of domestic practice are also preserved. This definitely extends the scope of application of the domestic codes, contributing both to changing the mentality of design engineers and to improving the design process itself. In particular, the main method for calculating the wooden structures in the codes is the method of boundary states. However, the probabilistic method is not even mentioned, even though it is recommended for use in accordance with the requirements of DBN B.1.2-14-2009 [2].

Also, among the positive points I would like to note the introduction of settlement expressions in the work of elements on torsion, as well as a section for evaluating the dynamic characteristics of bending elements, which were not present in the previous codes SNiP II-25-80. Particular attention is paid to modern wood products and its derivatives (LVL, OSB, MDF). Also, the wooden structure work theory with the consideration of nonlinear properties was substantially developed, which the author emphasized in his previous works (see, for example, [11]).

Additionally, the new codes DBN B.2.6-161:2017 regulate the issues related to ensuring the protection of wooden structures from fire, biological pests and corrosion. These issues in the previous codes SNiP II-25-80 were covered in

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a rather narrow way, and there was no explicit separation of constructive protection measures for various external factors.

However, the new codes DBN B.2.6-161: 2017 also have a number of negative points, which I would like to dwell upon in more detail. They are listed in the order according to the recommendations in the code text.

1. The exposure duration load class values given in clause 5.3.2 are not consistent with the classification of loads given in DBN B.1.2-2:2006 [1] both quantitatively and qualitatively. In particular, the order of distribution of load duration is not clear, since, for example, a seismic load can take several minutes, which, as a result, should be attributed to short-term loads. Also, there is the question of limiting the duration of permanent loads for 10 years.

2. The operating classes listed in clause 5.3.3 include a rather narrow temperature-humidity range, as compared to SNiP II-25-80. In turn, a number of calculation characteristics depend on these classes, which cannot be determined for other conditions, for example, conditions of unheated premises or in dry humidity mode, etc.

3. In the previous codes SNiP II-25-80, the specific conditions of the wooden structure work are factored in a number of special coefficients, denoted as *m* (par. 3.2). However, the new codes DBN B.2.6-161: 2017 present the system of only two coefficients – k_h and k_{def}. The first of these is related to the size of the elements, served only as the recommended, actually replaces the four coefficients according to the previous codes for different types of sections. The second coefficient takes into account the rheological properties of wood and actually «replaces» two coefficients according to the previous codes for different types of loads. However, the open question is to take into account certain features of the real conditions of operation of structures. These include, for example, taking into account the impregnation of wood with flame retardants or antiseptics, or an elevated (lowered) operating temperature.

4. Section 9 and, in general, the text of the codes does not set the limits as to the boundary flexibility, at least for compressed elements This is, in the opinion of the author of this publication, is fundamentally wrong, since limitation of flexibility is one of the basic moments when designing structures from any materials [3, 6-8]. In the previous codes SNiP II-25-80, the boundary flexibility is also limited (table 14 [9]).

5. In clause 9.2, when calculating the stretched elements, the area on which all the weakening of the calculated section must be combined is reduced from 20 cm (according to the recommendations of the previous SNiP II-25-80 codes) to 15 cm. There is no justification for such a recommendation, which creates certain difficulties in the calculation of connections with numerical openings, for example, for nail joints.

6. In clause 9.4, when calculating bending elements, a recommendation is made regarding the need to combine all weakening of the cross-section, located at a length of 15 cm in one design section. This is a new requirement, absent in the previous codes SNiP II-25-80. However, such an approach raises a difficult question when calculating, for example, the horizontal element of the skew notch (Annex K). Traditionally, according to domestic professional literature [12, 13], this element is tested by two sections – weakened for central compression and complete for non-center compression. According to the new requirements it follows that the test should be performed only for the cross-section for non-center stretching, which requires additional justification

7. Paragraph 12.5 on the cylindrical nailed connections takes 22 pages out of 78 pages of the text of the codes (28%). For comparison, in the previous codes SNiP II-25-80 this paragraph occupied 4 pages out of 27 pages of the text of the codes (15%). In our opinion, this paragraph in the new codes DBN B.2.6-161:2017 would be expedient to structure, singling out a sequence of determining the bearing capacity of the connections of the type under consideration, the constructive requirements to them, as well as the scope of their application. Instead, all of these recommendations are actually in a mixed style, which makes it very difficult to implement them.

8. Among the standard characteristics of tensile strength listed in Annex B, there is no bearing stress. Instead, a link to the following characteristics is provided in annex K, which is dedicated to the contact connection. Also, according to the author, the codes paid little attention to the contact

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connections, although wooden structures with such connections (especially with skew notches) are found to be in operation not so rarely, for example, in previously constructed structures with wood truss covering.

9. There is a lack of complete information on such constructional elements as the dowel beams, and in particular the connection on the tongue pieces. Certainly, this kind of connections is not widespread and quite effective, however, as in the case of contact connections, similar structures are found in the design practice, even in the modern foreign one [15, 17].

10. Such a widely used in the domestic design practice concept as «wood grade» [12, 13] is mentioned only in one place of the codes (reference appendix G). The linkage of this concept with the classes of timber strength is given without any justification. Also, in our view, it would be advisable to supplement the codes with the recommendations or method for determining the type of wood for practical purposes, since this question is treated fairly freely in the existing professional and reference literature.

11. The transition to the use of strength classes should be accompanied by detailed explanations regarding the methodology for determining these classes for different wood materials, which is completely absent in the codes. In fact, in design practice there is a difficult situation, which is to correctly refer the existing wood or a product thereof to a specific strength class. As far as can be understood from the text of the codes for this purpose, it is necessary to conduct special laboratory tests, during which certain characteristics of strength will be determined. However, the use of the very class of strength with such an approach is simply superfluous.

In this regard, let us dwell separately on the comparison of the characteristics of the calculated strength of wood, which should be determined according to the new codes DBN B.2.6-161:2017 in relation to the previous codes SNIP II-25-80.

Under the new codes, the calculated resistance of wood should be determined by the expression:

$$f_d = \frac{f_k}{\gamma_M} \cdot k_{\text{mod}}, \qquad (1)$$

where f_k – characteristic value of wood resistance by the Appendix B of DBN B.2.6-161:2017; γ_M – material reliability coefficient by the table 6.1 of DBN B.2.6-161:2017; k_{mod} – conversion factor by the table A.1 of the Appendix A of DBN B.2.6-161:2017.

According to the previous codes, the calculated resistance of wood was determined without any additional calculations directly by the Table 3.

We will perform the comparison of the calculated resistance values for the most widespread case of solid softwood, for which $\gamma_M = 1.3$ according to the new codes. Let us consider the cases of the most common, in design practice, types of loads by exposure duration – permanent, long-term and short-term. The results obtained are shown in Table 1, where the values for the 1st and 2nd operational classes according to the new codes (operation conditions of A1 and A2 according to the previous codes) were given in the numerator, and in the denominator – for the 3rd operating class according to the new codes (operation conditions of A3 according to the previous codes).

As can be seen from this table, in general, the calculated resistances according to the previous codes are higher than those by the new codes. To quantify this difference the last column «Difference» of Table 1 shows the calculated ratio of the largest value in the corresponding line of wood resistance according to the previous codes to the smallest value according to the new codes within the grades. It is seen that the difference reaches 3 times.

The values of the calculated resistance in Table 1 are given for a constant load, when the coefficient $k_{mod} = 0.6$ (0.5 for the 3rd operating class) according to the new codes DBN B.2.6-161:2017. For a long-term load this coefficient is equal to $k_{mod} = 0.7$ (0.55 for the 3rd operating class), and for short-term load $k_{mod} = 0.9$ (0.70 for the 3rd operating class). This means that for these types of loads, the difference in the values of the calculated resistance will decrease and will reach 2.5 and 2 times, respectively.

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Table 1

Estimated resistance of wood (MPa)

Stressed state	DBN B.2.6-161:2017 for strength classes			SNIP II-25-80 for wood grades			Difference (times)
	C30	C27, C24, C20	C18, C16, C14	1st	2nd	3rd	
Bending	$\frac{13.85}{11.54}$	$\frac{12.46}{10.38} \div \frac{9.23}{7.69}$	$\frac{8.31}{6.92} \div \frac{6.46}{5.38}$	$\frac{16.00}{14.40} \div \frac{14.00}{12.60}$	$\frac{15.00}{13.50} \div \frac{13.00}{11.70}$	$\frac{11.00}{9.90} \div \frac{8.50}{7.65}$	$\frac{1.76}{1.84}$
Axial tension	$\frac{8.31}{6.92}$	$\frac{7.38}{6.15} \div \frac{5.54}{4.62}$	$\frac{5.08}{6.15} \div \frac{3.69}{3.08}$	$\frac{10.00}{9.00}$	$\frac{7.00}{6.30}$	–	$\frac{1.26}{1.36}$
Lateral tensions	$\frac{0.18}{0.15}$			–			–
Axial compression	$\frac{10.62}{8.85}$	$\frac{10.15}{8.46} \div \frac{8.77}{7.31}$	$\frac{8.31}{6.92} \div \frac{7.38}{6.15}$	$\frac{16.00}{14.40} \div \frac{14.00}{12.60}$	$\frac{15.00}{13.50} \div \frac{13.00}{11.70}$	$\frac{11.00}{9.90} \div \frac{8.50}{7.65}$	$\frac{1.71}{1.84}$
Lateral compression	$\frac{1.25}{1.04}$	$\frac{1.20}{1.00} \div \frac{1.06}{0.88}$	$\frac{1.02}{0.85} \div \frac{0.92}{0.77}$	$\frac{1.80}{1.62}$			$\frac{1.96}{2.10}$
Shear	$\frac{0.92}{0.77}$			$\frac{2.40}{2.16} \div \frac{1.60}{1.44}$	$\frac{2.10}{1.89} \div \frac{1.50}{1.35}$		$\frac{2.61}{2.81}$

12. Also, there are some issues with respect to terminology, in particular, its coordination, for example, with the existing DBN B.1.2-14:2009 [2] regarding the definition of boundary states, hazardous calculation situations, the use of liability classes and categories, etc.

Another feature of the newly introduced normative document DBN B.2.6-161:2017 is the complete absence of any recommendations regarding the possibilities of calculating wooden structures applying one of the most widely used numerical methods of building mechanics – the finite element method. After all, such calculations have a number of very specific features, such as [14, 16, 18].

Originality and practical value

The analysis of recently introduced new standard in the design of structures made of wood DBN B.2.6-161:2017 was carried out by the author of the publication not only in terms of assessing quality requirements and recommendations, but also in terms of the quantitative aspect of the issue. In particular, the author's experience in calculating simple elements and basic types of connections according to the new codes DBN B.2.6-161:2017 indicates that the bearing capacity determined for various cases is lower on average by 1.5 – 3 times than according to the previous codes SNiP II-25-80. This is due both to the transition to a new system of working condition coefficients and to the application of strength classes for determining the wood resistance. In turn, from a practical point of view, this revealed discrepancy means that already constructed structures may require some kind of reinforcement or reconstruction, in order to comply with the latest standards of DBN B.2.6-161:2017, and on the other hand, the new structures being designed should have larger bearing cross-sections of elements and, accordingly, greater bearing capacity and weight, in comparison with the previous codes SNiP II-25-80.

Conclusions

In general, the new codes DBN B.2.6-161:2017, recently introduced into design practice, are progressive both in their content and in terms of their use in construction practice. However, the existing problem areas in these

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codes, in our opinion, can significantly limit the possibility of their wide practical use. In addition, the bearing capacity of building structures made of wood, designed according to these standards, is several times higher than the one according to the previous ones (SNiP II-25-80), and existing structures may require some kind of reinforcement or reconstruction for compliance with the latest standards (DBN B.2.6-161:2017).

Certainly, other users of the codes may find some other difficulties or «bottlenecks» in the recently introduced new standards, but according to the author, the above is enough for publishing by developers of either special amendments to the codes, or additional comments to their application.

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ПЕРСПЕКТИВИ ВИКОРИСТАННЯ ДБН В.2.6-161:2017 «ДЕРЕВ'ЯНІ КОНСТРУКЦІЇ» В ПРОЕКТНІЙ ПРАКТИЦІ

Мета. Із 01.02.2018 в практику проектування конструкцій із дерева введені нові державні норми ДБН В.2.6-161:2017. Вони замінюють використовувані донедавна норми ДБН В.2.6-161:2010, які, у свою чергу, були покликані замінити СНиП II-25-80. Автор цієї публікації ставить за мету звернути увагу розробників і потенційних користувачів норм ДБН В.2.6-161:2017 на суперечливі моменти, які викликають певні труднощі їх практичного застосування. **Методика.** Накопичений за час навчальної практики досвід роботи з нормативною літературою, а також наявні напрацювання під час проведення лабораторних занять зі студентами дозволили проаналізувати нещодавно запроваджені норми ДБН В.2.6-161:2017 з практичної точки зору. **Результати.** У цілому введені в практику проектування нові норми є прогресивними як за своїм змістом, так і з точки зору використання. Проте наявні проблемні моменти в цих нормах, які розглянуті в нашій публікації, можуть суттєво обмежувати можливість їх широкого практичного застосування. **Наукова новизна.** Аналіз зазначених норм був виконаний не тільки в частині оцінки якісних вимог та рекомендацій, а й з точки зору кількісної сторони питання. **Практична значимість.** Авторський досвід проведення розрахунків простих елементів та основних видів з'єднань за новими нормами ДБН В.2.6-161:2017 свідчить про те, що визначена для різних випадків несуча здатність виявляється нижчою в середньому в 1,5–3 рази порівняно зі старими нормами СНиП II-25-80. Із практичної точки зору така виявлена розбіжність означає, що вже збудовані конструкції можуть потребувати певного підсилення або реконструкції, а конструкції, які проектують, повинні мати більші несучі перерізи елементів і, відповідно, більшу несучу здатність і вагу.

Ключові слова: конструкції з дерева; дерев'яні конструкції; норми; нормативний документ; ДБН В.2.6-161:2017; ДБН В.2.6-161:2010; СНиП II-25-80

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ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ ДБН В.2.6-161:2017 «ДЕРЕВЯННЫЕ КОНСТРУКЦИИ» В ПРОЕКТНОЙ ПРАКТИКЕ

Цель. С 01.02.2018 в практику проектирования конструкций из дерева введены новые государственные нормы ДБН В.2.6-161:2017. Они заменяют используемые до недавнего времени нормы ДБН В.2.6-161:2010, которые, в свою очередь, были призваны заменить СНиП II-25-80. Автор данной публикации ставит своей целью обратить внимание разработчиков и потенциальных пользователей норм ДБН В.2.6-161:2017 на противоречивые моменты, которые вызывают у него определенные сложности их практического использования. **Методика.** Накопленный за время учебной практики опыт работы с нормативной литературой, а также имеющиеся наработки во время проведения лабораторных занятий со студентами позволили проанализировать недавно введенные нормы ДБН В.2.6-161:2017 с практической точки зрения. **Результаты.** В целом введенные в практику проектирования новые нормы являются прогрессивными как по своему содержанию, так и с точки зрения использования. Однако имеющиеся проблемные моменты в этих нормах, которые рассмотрены в данной публикации, могут существенно ограничивать возможность их широкого практического применения. **Научная новизна.** Анализ указанных норм был выполнен не только в части оценки качественных требований и рекомендаций, но и с точки зрения количественной стороны вопроса.

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Практическая значимость. Авторский опыт проведения расчетов простых элементов и основных видов соединений по новым нормам ДБН В.2.6-161:2017 свидетельствует о том, что определенная для различных случаев несущая способность оказывается ниже в среднем в 1,5–3 раза по сравнению со старыми нормами СНиП II-25-80. С практической точки зрения такое выявленное расхождение означает, что уже построенные конструкции могут требовать определенного усиления или реконструкции, а проектируемые должны иметь большие несущие сечения элементов и, соответственно, большую несущую способность и массу.

Ключевые слова: конструкции из дерева; деревянные конструкции; нормы; нормативный документ; ДБН В.2.6-161:2017; ДБН В.2.6-161:2010; СНиП II-25-80

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