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COMPARATIVE ANALYSIS OF THE OVERALL STABILITY OF STEEL BAR ELEMENTS ACCORDING TO UKRAINIAN STANDARDS

This publication presents the results of a comparative analysis of the overall stability of steel bar elements. The analysis was performed based on calculation methods according to Ukrainian standards. Three main methods were considered: the classical method, reflected in the now-repealed standard SNiP II-23-81*, the domestic method, reflected in the current standard DBN V.1.2-14:2018, and the European method reflected in the implemented standard DSTU-N B EN 1993-1-1:2010. The selection of cross-sections of elements based on these methods involved the use of current product range in the design of steel structures. Five types of open and closed cross-sections were analysed, which are the most common in modern engineering design practice: round hot-rolled seamless pipe, cold-formed closed rectangular profile, hot-rolled I-beam, hot-rolled T-beam and hot-rolled equal-leg angles. In order to obtain extensive statistical material for further analysis, core elements with lengths of 1.5 m, 3 m and 4.5 m were considered. Calculations were performed for steels with strength levels of 200 MPa, 240 MPa and 280 MPa. In all calculation cases, loads ranging from 100 kN to 1900 kN were applied in increments of 200 kN.

The comparative analysis of the obtained results showed that the minimum cross-sectional area required to ensure overall stability is calculated using the domestic methodology reflected in the current standard DBN V.1.2-14:2018. Higher cross-sectional area values were obtained in accordance with the European method reflected in the implemented standard DSTU-N B EN 1993-1-1:2010. The highest values correspond to the classic methodology reflected in the now-repealed standard SNiP II-23-81*. Moreover, this trend remains for all considered steel strength levels, element lengths and types of cross-sections considered.

In quantitative terms, the mass indicators obtained for central compression bars in normalized form in relation to standard DBN V.1.2-14:2018 reach values of 1.53 for standard DSTU-N B EN 1993-1 -1:2010 and 1.83 for the standard SNiP II-23-81*.

Keywords: overall stability, steel bar element, DBN V.1.2-14:2018, DSTU-N B EN 1993-1-1:2010, SNiP II-23-81*.

Problem statement. The stability of structural elements is traditionally understood as their ability to maintain their initial position and corresponding primary equilibrium shape in a deformed state. Ensuring the stability of structural elements has been and remains a rather topical issue for several reasons.

Firstly, in the practice of operating structures, the initial signs of loss of stability are often absent, and failure occurs suddenly. Secondly, the introduction into design practice of mandatory analysis of building structures for progressive destruction in accordance with the Ukrainian standard [1] requires a thorough understanding of the specifics of the operation of various structural systems. This is due to the fact that the weakening of even a relatively insignificant element can trigger a chain reaction of enormous proportions within a matter of seconds.

The available generalised statistics on accidents and failures of steel building structures, summarised from classical sources in [2], show that the distribution of the main causes is as follows:

- loss of general and local stability – 41.2%;
- plastic destruction – 8.0%;
- brittle failure – 14.2%;
- fatigue strength exhaustion – 3.2%;
- failure of welded joints – 23.8%;
- failure of bolted joints – 3.2%;
- other causes – 6.3%.

As can be seen, loss of stability ranks first in terms of the number of failures and accidents. In second place there are accidents caused by the destruction of welded joints, the number of which is approximately half as many. The third main cause of failures in steel structures is brittle fracture. Thus, controlling the stability of steel structures will affect their overall reliability and durability.

Analysis of recent studies and publications. In engineering practice, there are many known cases of building structure collapsing due to the loss of stability of individual load-bearing elements. Some of these cases have been documented because their consequences were very significant, but many cases remained at the level of local failures.

Perhaps one of the first historically confirmed cases should be considered the accident at the Agricultural Museum in 1918 (Fig. 1), whose roof was made on the basis of steel arches with a span of more than 30 m with tie rods. In the areas opposite the two arches, formwork was made for the installation of lighting. The roof in these areas curved around the formwork and ran at some distance from the arches, so the parts of the arches adjacent to the support hinges in the areas under the formwork acted as flat trusses, compressed in the longitudinal direction, and lost their stability.

A selection of modern documented cases of accidents related to the loss of stability of core elements is given in [3]. Among them, the following deserve attention.

1. First of all, it is worth noting the accident at industrial workshop 420 of the Kirov plant in 2010 (Fig. 2). The workshop was built in 1940. The overall dimensions of the building are 24×12 m. The height to the top of the parapet is 11.5 m, to the bottom of the load-bearing structures of the roof is 9.7 m. The building is one-storey. The total area of the collapse was 1,800 m². During the investigation into the causes of the accident, it was established that the collapse was caused by the loss of stability of the upper chord of the roof truss under high snow loads in the winter of 2009-2010. After the collapse of the roof truss, the progressive destruction of the building's frame structures began, which was stopped only by two bridge cranes.
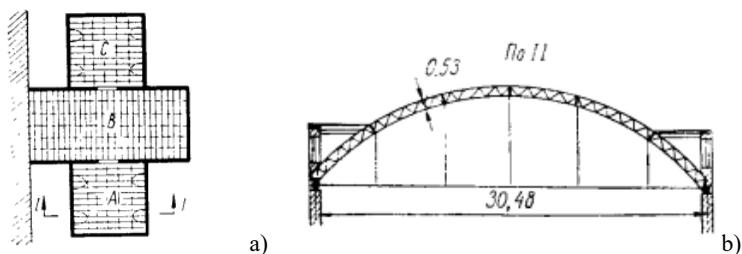
Figure 1. Diagram of the Agricultural Museum covering:
a – plan; b – diagram of a double-hinged arch with a tie rod

Figure 2. Diagram of the wrecked truss in workshop 420 of the Kirov Plant

2. Another documented example is the accident on 4 February 2013 involving the roof truss of the Peresvit Ice Palace. In 2007, the palace was opened after 11 months of construction. The accelerated pace of construction was explained by the fact that the building was being constructed as part of a social programme for the construction of sports facilities. At the time of the accident, there were 15 children on the ice rink. Fortunately, everyone managed to avoid injury. The palace's design involved the use of light steel trusses and a canvas cover stretched over them. From the photograph (Fig. 3), it is possible to estimate the thickness of the snow layer on the roof surface: about 400 mm. It is also clear that the load is unevenly distributed. The second half of the roof is covered with snow, which is unlikely to exceed 200 mm. It is likely that the designers did not take into account the possibility of uneven loading of the roof, as well as the possible loss of brace stability.

Figure 3. Collapse of steel trusses at the Peresvit Ice Palace

3. Another well-known accident occurred in Almaty on 12 January 2013, when the roof of Gymnasium No. 111 collapsed (Fig. 4). The school canteen, built in 1966, was renovated in the summer of 2012. The roofing was replaced with profiled sheet metal. The accident occurred because the designers did not take into account the condition of the roof load-bearing structures. Following the roof of the extension, the truss girders of the canteen also lost their stability. The total area of the collapse was 450 m². The project was developed by PSK Asia Lad LLP.

Figure 4. Collapse of the roof of Gymnasium No. 111

4. Another example of loss of stability due to wear and tear of steel trusses is the accident that occurred on 23 March 2013 in Chita. The sports hall building collapsed (Fig. 5), which had been closed for renovation for 10 months. No classes were held there. The cause of the collapse was the loss of stability of the metal truss elements.

In general, the problem of stability assessment is covered quite extensively in specialised professional literature. Since stability is a rather multifaceted phenomenon, there are quite a number of areas of its development. The fundamental three-volume work by specialists A.V. Perelmuter and V.I. Slivker, "Stability of Equilibrium of Structures and Related Problems", is widely known and presents modern theoretical information in a systematic and generalised form.

Figure 5. Collapse of a metal roof truss

However, when designing real construction projects, the accidents of which are described above, engineers are more interested in the applied aspects of stability theory, especially the stability of classic profile bars. Among modern domestic specialists in this field, there are works [4-16] devoted to the analysis of the stability of bars taking into account imperfections. This direction is in fact the main and only relevant area of research, which is largely focused on open-type profiles. However, current standards play a major role in the design of bar elements of building structures.

In Ukraine, the calculation of the stability of bar elements is regulated by standards [15]. Widespread awareness of European approaches among the public will contribute to the dissemination of European standards among engineers, which are also used in design. The stability of bar elements can be assessed according to standards [16]. In Ukraine, the implemented version of this standard is the norms [17].

Purpose of the research. The purpose of the work is a comparative analysis of the results of calculating the overall stability according to the requirements of two normative documents DBN [17] and DSTU-B EN [19].

To achieve the purpose, comparative analytical calculations were performed using the methods described above. The results obtained were scientifically summarised.

Materials and research methods. During the research, three main parameters that significantly affect the loss of overall stability were changed: design resistance, bar length, and bar cross-section type. The design resistance varied in the range of 200-280 MPa (such steels were widely used for steel structures in the late 20th and early 21st centuries [20]), and the length varied in the range of 1.5-4.5 m. The following types of bar cross-

sections were used:
- round hot-rolled seamless pipe (cross-section No. 1);
- cold-formed closed rectangular profile (cross-section No. 2);
- hot-rolled I-beam (cross-section No. 3);
- hot-rolled T-bar (cross-section No. 4);
- hot-rolled equal-leg angles (cross-section No. 5).

During the calculations, the force applied to the bar element was also varied in the range of 100-1900 kN.

These parameters were selected in order to cover the entire range of profile sizes most commonly found in steel bar element structures, primarily truss-type structures.

It should be noted that special attention was paid to assessing the overall stability using the old method in accordance with SNiP II-23-81*. This makes it possible to analyse the effectiveness of the transition from this method to the method set out in the new Ukrainian standard DBN V.2.6-163:2014 [17].

Research results. The results obtained during comparative calculations for the length of bar elements of 3 m are presented in in Tables 1-5 – the values of the selected areas (in cm^2) for sections No. 1 - No. 5, respectively, are given.

Table 1

Selected areas for section No. 1

Force, kN	Design resistance of steel (MPa)								
	200			240			280		
	SNiP	DBN	DSTU	SNiP	DBN	DSTU	SNiP	DBN	DSTU
100	12.06	5.89	9.04	10.69	5.89	10.22	10.69	5.89	10.22
200	13.82	10.69	16.72	18.86	9.19	12.32	12.32	8.17	13.20
300	20.35	15.47	19.22	16.21	13.20	15.47	20.06	11.44	16.19
400	26.39	20.35	25.07	31.30	17.20	20.10	26.30	15.59	20.35
500	30.57	26.30	29.91	26.39	21.87	26.39	33.92	19.74	28.91
600	36.19	31.30	38.46	38.46	26.30	27.49	31.68	22.95	26.39
700	42.39	36.20	40.84	38.65	29.91	36.75	33.18	26.71	31.42
800	52.35	41.10	43.25	40.20	34.86	37.96	36.19	29.69	34.68
900	58.83	45.63	49.61	44.94	38.65	42.39	37.12	33.92	38.74
1000	65.35	50.52	55.45	52.78	43.38	52.35	48.24	36.75	43.25
1100	68.36	55.45	63.78	62.35	47.05	52.78	46.76	41.10	44.94
1200	68.60	60.70	68.36	57.78	50.52	62.35	58.06	43.38	48.35
1300	79.73	68.36	75.78	68.36	55.79	65.35	60.70	48.24	55.45
1400	82.44	71.88	79.73	68.60	58.84	68.36	63.78	52.35	62.35
1500	89.52	75.18	82.44	76.42	63.78	71.88	67.76	55.79	65.35
1600	94.00	82.90	89.52	79.18	68.36	72.01	75.78	58.83	67.76
1700	100.53	87.34	94.00	83.12	71.88	82.90	76.42	62.35	71.88
1800	104.58	91.61	100.53	93.00	76.42	84.84	79.18	65.35	73.01
1900	109.34	99.50	104.58	94.00	82.90	93.00	84.84	68.60	82.90

Table 2

Selected areas for section No. 2

Force, kN	Design resistance of steel (MPa)								
	200			240			280		
	SNiP	DBN	DSTU	SNiP	DBN	DSTU	SNiP	DBN	DSTU
200	22.60	11.60	18.90	14.20	9.20	11.60	22.60	8.60	11.60
300	22.90	17.80	27.40	18.50	13.90	18.90	22.60	11.60	14.20
400	27.40	22.60	26.30	22.90	17.80	22.90	27.40	15.30	22.60
500	32.10	26.30	27.70	26.90	22.60	24.60	27.40	18.90	27.40
600	37.20	30.70	37.20	32.10	26.30	27.70	29.00	22.60	27.40
700	42.80	37.20	42.30	37.20	30.70	37.20	30.70	26.30	32.00
800	48.70	41.40	42.80	42.80	34.60	37.20	42.30	30.70	37.20
900	54.80	48.20	48.70	48.70	41.40	42.30	42.30	34.60	37.20
1000	61.30	54.80	54.80	48.20	42.30	48.70	48.70	37.20	42.30
1100	67.70	61.30	54.80	54.80	48.70	54.80	48.70	42.30	48.20
1200	75.80	61.30	67.70	61.30	54.80	54.80	54.80	48.20	48.70
1300	75.80	67.70	75.80	67.70	54.80	61.30	54.80	48.20	54.80
1400	84.70	75.80	75.80	67.70	61.30	67.70	61.30	54.80	54.80
1500	84.70	75.80	84.70	75.80	67.70	67.70	67.70	54.80	61.30
1600	93.40	84.70	84.70	75.80	67.70	75.80	67.70	61.30	61.30
1700	93.40	93.40	93.40	84.70	75.80	75.80	75.80	61.30	67.70
1800	102.00	93.40	93.40	84.70	75.80	84.70	75.80	67.70	75.80
1900	111.00	102.00	102.00	93.40	84.70	84.70	75.80	75.80	75.80

Table 3

Selected areas for section No. 3

Force, kN	Design resistance of steel (MPa)								
	200			240			280		
	SNiP	DBN	DSTU	SNiP	DBN	DSTU	SNiP	DBN	DSTU
200	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95
300	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95
400	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95
500	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95
600	46.08	38.95	38.95	38.95	38.95	38.95	38.95	38.95	38.95
700	54.37	38.95	46.08	46.08	38.95	46.08	38.95	38.95	38.95
800	54.37	46.08	54.37	54.37	38.95	46.08	46.08	38.95	46.08
900	62.37	54.37	54.37	54.37	46.08	54.37	54.37	38.95	46.08
1000	68.31	54.37	62.37	62.37	46.08	54.37	54.37	38.95	54.37
1100	68.31	62.37	62.37	62.37	62.37	62.37	62.37	46.08	54.37
1200	77.65	62.37	77.65	68.31	62.37	62.37	62.37	46.08	62.37
1300	95.67	68.31	77.65	77.65	62.37	68.31	68.31	54.37	62.37
1400	95.67	77.65	95.67	77.65	62.37	77.65	68.31	54.37	68.31
1500	95.67	77.65	95.67	95.67	68.31	77.65	77.65	62.37	68.31
1600	95.67	95.67	95.67	95.67	68.31	95.67	77.65	62.37	77.65
1700	104.74	95.67	95.67	95.67	77.65	95.67	95.67	68.31	77.65
1800	104.74	95.67	104.74	95.67	77.65	95.67	95.67	68.31	77.65
1900	122.40	104.74	104.74	95.67	95.67	95.67	95.67	77.65	95.67

Table 4

Selected areas for section No. 4

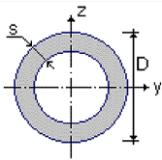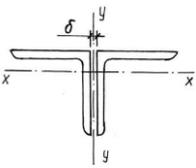| Force, kN	Design resistance of steel (MPa)								
	200			240			280		
	SNiP	DBN	DSTU	SNiP	DBN	DSTU	SNiP	DBN	DSTU
200	7.39x2	6.13x2	6.13x2	6.13x2	4.80x2	6.13x2	6.13x2	4.38x2	7.28x2
300	10.85x2	8.78x2	10.85x2	9.38x2	7.28x2	9.42x2	8.15x2	6.13x2	8.78x2
400	12.82x2	10.85x2	12.82x2	13.30x2	9.42x2	13.30x2	10.15x2	8.15x2	11.50x2
500	15.15x2	13.75x2	15.60x2	13.75x2	11.50x2	13.93x2	13.30x2	10.15x2	12.82x2
600	19.24x2	17.20x2	19.24x2	17.20x2	13.93x2	17.20x2	13.75x2	13.30x2	15.60x2
700	22.80x2	19.24x2	22.80x2	19.24x2	15.60x2	19.24x2	15.15x2	13.75x2	17.20x2
800	24.33x2	22.00x2	24.33x2	22.80x2	19.24x2	22.80x2	19.24x2	15.60x2	19.24x2
900	29.68x2	24.33x2	29.68x2	24.33x2	19.69x2	24.33x2	19.69x2	17.20x2	19.69x2
1000	31.43x2	28.89x2	28.89x2	24.72x2	22.00x2	26.28x2	22.80x2	19.24x2	22.00x2
1100	31.43x2	28.89x2	31.43x2	29.68x2	24.33x2	29.68x2	24.33x2	22.00x2	26.28x2
1200	34.42x2	31.43x2	34.42x2	32.49x2	26.28x2	33.37x2	24.72x2	22.00x2	29.68x2
1300	33.37x2	34.42x2	33.37x2	32.49x2	28.89x2	33.37x2	27.33x2	24.72x2	27.33x2
1400	38.80x2	33.37x2	38.80x2	34.42x2	31.43x2	34.42x2	31.43x2	27.33x2	33.37x2
1500	42.19x2	38.80x2	42.19x2	33.37x2	33.37x2	33.37x2	31.43x2	28.89x2	33.37x2
1600	47.10x2	42.19x2	47.10x2	38.80x2	37.39x2	37.39x2	33.37x2	31.43x2	34.42x2
1700	47.10x2	43.57x2	47.10x2	42.19x2	38.80x2	38.80x2	34.42x2	31.43x2	33.37x2
1800	50.85x2	47.10x2	49.07x2	42.19x2	42.19x2	42.19x2	33.37x2	34.42x2	37.39x2
1900	54.79x2	49.07x2	50.85x2	47.10x2	47.10x2	47.10x2	38.80x2	33.37x2	38.80x2

Table 5

Selected areas for section No. 5

Force, kN	Design resistance of steel (MPa)								
	200			240			280		
	SNiP	DBN	DSTU	SNiP	DBN	DSTU	SNiP	DBN	DSTU
200	22.81	19.27	22.81	22.81	19.27	19.27	19.27	19.27	19.27
300	26.94	19.27	26.94	26.94	19.27	19.27	22.81	19.27	22.81
400	31.10	22.81	31.10	31.10	22.81	31.10	26.94	19.27	26.94
500	33.87	31.10	33.87	33.87	26.94	33.87	31.10	22.81	31.10
600	43.18	33.87	38.87	38.87	31.10	38.87	33.87	26.94	33.87
700	47.50	38.87	47.50	43.18	33.87	43.18	33.87	31.10	38.87
800	52.02	47.50	47.50	47.50	38.87	47.50	38.87	33.87	43.18
900	57.78	52.02	60.84	52.02	43.18	52.02	47.50	38.87	47.50
1000	60.84	57.78	70.37	57.78	47.50	57.78	47.50	38.87	47.50
1100	70.37	60.84	70.37	60.84	52.02	60.84	52.02	43.18	57.78
1200	78.14	60.84	78.14	70.37	52.02	70.37	57.78	43.18	57.78
1300	78.14	70.37	72.49	70.37	60.84	70.37	60.84	52.02	60.84
1400	87.81	78.14	87.81	78.14	70.37	78.14	60.84	57.78	70.37
1500	87.81	87.81	87.81	78.14	70.37	78.14	70.37	60.84	70.37
1600	90.10	87.81	99.04	87.81	70.37	87.81	70.37	60.84	78.14
1700	99.04	87.81	99.04	87.81	78.14	87.81	72.49	70.37	78.14
1800	110.28	99.04	110.28	87.81	87.81	87.81	72.49	70.37	87.81
1900	110.28	99.04	110.28	90.10	87.81	99.04	87.81	72.49	87.81

As can be seen from the results obtained, the areas are quite dense and generally reflect the same trend regardless of the strength of the steel and the types of cross-section of the bar elements.
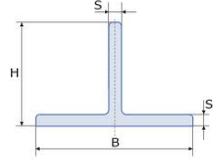
The comparison of the results of analytical calculations shows that, according to DBN V.2.6-163:2014 [17], the selected profiles have the lowest mass for all types of cross-sections considered. The cross-sections calculated according to SNiP II-23-81* are the heaviest, while the cross-sections according to DSTU-N B EN 1993-1-1:2010 [19] occupy an intermediate position. The average normalised mass indicators in relation to DBN are presented in Table 6.

Table 6

Averaged mass indicators based on the results of cross-section selection

Cross-section type	Design resistance, MPa	Length, m	SNiP	DBN	DSTU
	200	1.5	1.27	1.0	1.13
		3.0	1.29	1.0	1.10
		4.5	1.22	1.0	1.17
	240	1.5	1.16	1.0	1.04
		3.0	1.33	1.0	1.12
		4.5	1.76	1.0	1.14
	280	1.5	1.12	1.0	1.06
		3.0	1.34	1.0	1.11
		4.5	1.83	1.0	1.19
	200	1.5	1.22	1.0	1.08
		3.0	1.24	1.0	1.10
		4.5	1.54	1.0	1.17
	240	1.5	1.28	1.0	1.06
		3.0	1.24	1.0	1.10
		4.5	1.57	1.0	1.14
	280	1.5	1.29	1.0	1.05
		3.0	1.38	1.0	1.21
		4.5	1.45	1.0	1.24
	200	1.5	1.18	1.0	1.18
		3.0	1.39	1.0	1.18
		4.5	1.53	1.0	1.24
	240	1.5	1.18	1.0	1.18
		3.0	1.35	1.0	1.18
		4.5	1.76	1.0	1.48
	280	1.5	1.14	1.0	1.14
		3.0	1.35	1.0	1.18
		4.5	1.69	1.0	1.48
	200	1.5	1.12	1.0	1.03
		3.0	1.22	1.0	1.22
		4.5	1.51	1.0	1.24
	240	1.5	1.14	1.0	1.02
		3.0	1.22	1.0	1.22
		4.5	1.52	1.0	1.31
	280	1.5	1.13	1.0	1.08
		3.0	1.19	1.0	1.14
		4.5	1.52	1.0	1.52
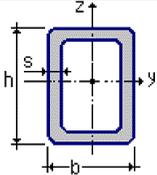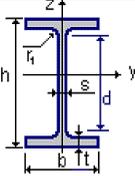
End of Table 6

Cross-section type	Design resistance, MPa	Length, m	SNiP	DBN	DSTU
	200	1.5	1.15	1.0	1.15
		3.0	1.27	1.0	1.15
		4.5	1.53	1.0	1.53
	240	1.5	1.2	1.0	1.2
		3.0	1.35	1.0	1.35
		4.5	1.50	1.0	1.39
	280	1.5	1.16	1.0	1.16
		3.0	1.22	1.0	1.22
		4.5	1.5	1.0	1.4

Thus, theoretically, when using the current DBN standard in Ukraine, the mass of bar structures for centrally compressed elements should be on average 30-50% lower than that calculated using the classic SNiP method and 10-20% lower than that calculated using the European DSTU method.

Conclusions.

1. Based on the analysis of current regulatory literature, it has been established that the regulatory methods for calculating the overall stability of bar elements of steel structures according to Ukrainian and European standards differ significantly. They must be performed in accordance with DBN V.2.6-163:2014, SNiP II-23-81* repealed in Ukraine, and the translated European standard DSTU-N B EN 1993-1-1:2010.

2. Comparing the stability calculations according to these three regulatory approaches, it should be noted that the calculations according to DBN V.2.6-163:2014 allow for the smallest cross-section area to be specified, while the calculations according to SNiP II-23-81* allow for the largest one. According to DSTU-N B EN 1993-1-1:2010, the results are intermediate.

3. The trend indicated in paragraph 2 remains unchanged when the length of the bar elements varies in the range of 1.5-4.5 m, the strength of steel varies in the range of 200-280 MPa, and for the most common closed and open cross-sections. At the same time, in quantitative terms, the difference in mass reaches 80% in some cases.

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Дмитро БАННІКОВ, Ігор БАКАН
Порівняльний аналіз загальної стійкості сталевих стержневих елементів за нормами України

В публікації представлені результати дослідження порівняльного аналізу загальної стійкості для сталевих стержневих елементів. Аналіз виконувався на основі розрахункових методик за стандартами в Україні. При цьому розглядались три основні методики – класична методика, відображена у відміненому на тепер стандарті СНиП ІІ-23-81*, вітчизняна методика, відображена в чинному стандарті ДБН В.1.2-14:2018, і європейська методика, відображена в імплементованому стандарті ДСТУ-Н Б ЕN 1993-1-1:2010. Виконаний на основі цих методик підбір поперечних перерізів елементів передбачав використання чинних сортаментів в галузі проєктування сталевих конструкцій. Аналізувались 5 типів поперечних перерізів відкритого та закритого типів, які є найбільш розповсюдженими в практиці сучасного інженерного проєктування: кругла гарячекатана безшовна труба, холодногнутий замкнений прямокутний профіль, гарячекатаний двотавр, гарячекатаний тавр і гарячекатані парні кутики. Для отримання широкого статистичного матеріалу для подальшого аналізу розглядались стержневі елементи довжиною 1,5 м, 3 м і 4,5 м. Розрахунки виконувались для сталей з рівнем міцності 200 МПа, 240 МПа і 280 МПа. В усіх розрахункових випадках прикладалось навантаження в діапазоні від 100 кН до 1900 кН з кроком 200 кН.

За результатами порівняльного аналізу отриманих результатів встановлено, що найменша необхідна площа поперечного перерізу для забезпечення загальної стійкості розраховується за вітчизняною методикою, відображеною в чинному стандарті ДБН В.1.2-14:2018. Більш високі показники площі поперечного перерізу отримані відповідно до європейської методики, відображеної в імплементованому стандарті ДСТУ-Н Б ЕN 1993-1-1:2010. Найбільші значення відповідатимуть класичній методиці, відображеній у відміненому на тепер стандарті СНиП ІІ-23-81*. Причому така тенденція зберігається для всіх розглянутих рівнів міцності сталі, довжин елементів та типів розглянутих поперечних перерізів.

В кількісному відношенні отримані масові показники стержневих елементів для центрально-стиснутих стержнів в нормалізованому вигляді по відношенню до стандарту ДБН В.1.2-14:2018 сягають значень 1,53 для стандарту ДСТУ-Н Б ЕN 1993-1-1:2010 і 1,83 для стандарту СНиП ІІ-23-81*.

Ключові слова: загальна стійкість, сталевий стержневий елемент, ДБН В.1.2-14:2018, ДСТУ-Н Б ЕN 1993-1-1:2010, СНиП ІІ-23-81*.