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***Storozhenko L.I.**, DSc, Professor*
ORCID 0000-0002-3764-5641
***Murza S.O.**, PhD, Associate Professor*
ORCID 0000-0002-3256-5634 s_murza@ukr.net
***Yefimenko O.I.,** post-graduate*
ORCID 0000-0001-5949-623Xu Lenysia_17.02@ukr.net
Poltava National Technical Yuri Kondratyuk University

CAPACITY FLEXIBLE COMPRESSED REINFORCED CONCRETE ELEMENTS REINFORCED WITH STEEL SHEETS

The experimental studies results of reinforced concrete elements with sheet reinforcement load bearing capacity are presented. The drawing of experimental designs is shown. The bearing capacity dependence graphs of the tested steel-reinforced concrete samples with sheet reinforcement on the height of the element and dependence graphs of tested steel-reinforced concrete samples with sheet reinforcement carrying capacity on the applied eccentricity are constructed. The photo shows the destruction character of experimental steel-concrete samples with sheet reinforcement depending on their height. The general schedule of bearing capacity dependence on the height of the element and the eccentricity of the applied load is constructed.

***Keywords:** composite reinforced concrete, bearing capacity, steel sheets, amount of eccentricity.*

***Стороженко Л.І.,** д.т.н., професор*
***Мурза С.О.,** к.т.н., доцент*
***Єфіменко О.І.,** аспірант*
Полтавський національний технічний університет імені Юрія Кондратюка

НЕСУЧА ЗДАТНІСТЬ ГНУЧКИХ СТИСНУТИХ СТАЛЕЗАЛІЗОБЕТОННИХ ЕЛЕМЕНТІВ, АРМОВАНИХ СТАЛЕВИМИ ЛИСТАМИ

Наведено результати експериментальних досліджень несучої здатності залізобетонних елементів із листовим армуванням. Зображено креслення конструкцій експериментальних зразків. Побудовано графіки залежності несучої здатності випробуваних сталезалізобетонних зразків з листовим армуванням від висоти елемента; графіки залежності несучої здатності випробуваних сталезалізобетонних зразків з листовим армуванням від прикладеного ексцентриситету. Наведено фото, на яких показано характер руйнування дослідних сталебетонних зразків з листовим армуванням залежно від їх висоти. Побудовано загальний графік залежності несучої здатності від висоти елемента та ексцентриситету прикладеного навантаження.

***Ключові слова:** сталезалізобетон, несуча здатність, листове армування, ексцентриситет.*

Introduction. Nowadays, reinforced concrete structures reinforced with rod reinforcement have become very popular. In these designs, concrete and reinforcement work along with the reinforcement fully absorb tensile stresses, although its work in the compressed zone is also effective. The construction of reinforced concrete structures is relevant. [4]. Use in the construction of prefabricated and monolithic structures with external sheet reinforcement requires a detailed study of their work, depending on their geometric dimensions and eccentricity of the acting load.

Review of the latest research sources and publications. Previously, experimental studies of bent elements with sheet reinforcement with different parameters were carried out [3]. To accomplish this work, compressed elements with reinforcing sheets 4 mm in thickness and a height of up to 1 m were investigated [2].

Definition of unsolved aspects of the problem. On the basis of the inspection performed during the experiments program development, the following items were planned:

– to produce prototypes of steel reinforced concrete pillars with sheet reinforcement 1000 mm high, 1700 mm, 2400 mm;

– determine the load-bearing capacity of samples as a result of centrally and centrally compressed elements with sheet reinforcement experimental studies;

– to reveal in the course of the study the peculiarities of deformations and displacements development, as well as the nature of steel-reinforced concrete elements destruction.

Problem statement. The purpose of the article is to obtain new data on the bearing capacity of central and non-centered flexural reinforced concrete reinforced concrete elements, depending on the flexibility of the samples and the eccentricity of the operating load.

Basic material and results. When compiling the experiment program, it was considered that the bearing capacity and the stress-strain state of the steel-reinforced concrete element depend on the constructive solution, the eccentricity of the load application and the physical and mechanical properties of the raw materials. The task was to experimentally determine experimentally the bearing capacity and features of work under compressed elements load with sheet reinforcement depending on their flexibility and eccentricity of the applied load.

For the production of experimental samples steel sheet t = 4 mm was used, cross-reinforcement class A-I ∅6 mm. The height of the samples was 1000, 1700, 2400 mm, the section 100x100 mm. To find out the work effectiveness of steel-concrete elements, a sample of steel without concrete with a height of 1000 mm was tested. Standard concrete cubes 150x150x150 mm and prisms 150x150x600 mm, made from the same concrete as the prototype samples were tested for definition of physical and mechanical properties of concrete filler.

Proceeding from the task, experimental designs were done for experimental ones which were divided into two groups: the first group of samples with reinforcing sheets in the plane of bending moment action (Fig. 1), the second group of samples with reinforcing sheets perpendicular to the bending moment (Fig. 2).

According to the existing normative documents on the design of bearing building constructions, it is necessary to perform calculations for both the first and the second group of boundary states. Considering this fact, experimental studies were conducted to obtain data on the bearing capacity and deformability of reinforced concrete steel racks. The developed method of conducting experimental researches and the design of prototypes conformed to these requirements.

As a result of the experiments it was established that the element height, type of reinforcement and other factors influence the process of destruction of steel concrete elements with sheet reinforcement in axial compression. In samples with sheet reinforcement in the middle section (for short samples), when the longitudinal deformations were equal to the limits of the metal fluidity, a grid in the form of Chernov lines was formed on the paint and varnish coating. On the concrete surface, free of sheet reinforcement, microcracks were combined into a macro crunch. The direction of these cracks coincided with the longitudinal axis of the prototype. Further, the sheet reinforcement releases due to the pressure of the concrete in the transverse direction with the formation of corrugations perpendicular to the longitudinal axis, on the area between adjacent rows of transverse clamps. The load resulted in destruction increases by breaking the clamps and breaking the concrete monolith. Concrete was rolled up and fell to the side, free of sheet reinforcement.

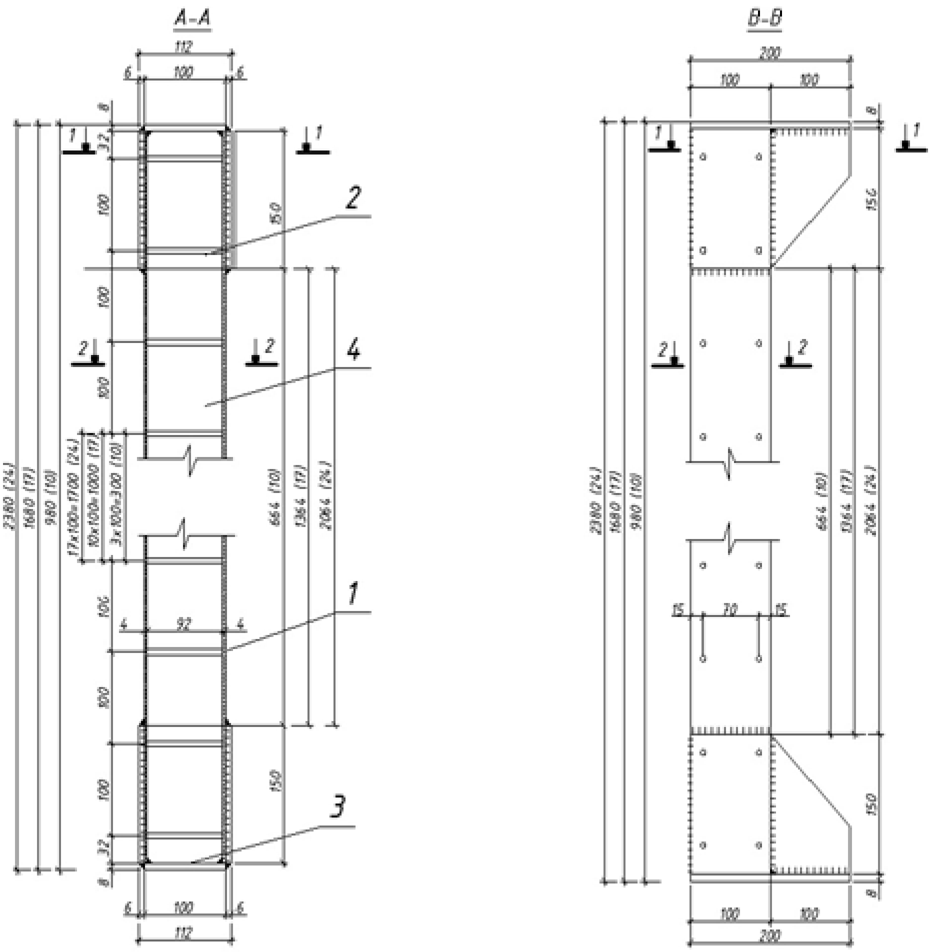

Figure 1 – Constructions of experimental samples with reinforcing sheets in the plane of bending moment action:
1 – sheet-iron plate; 2 – steel reinforcing rod; 3 – full metal; 4 – concrete

The aforementioned destruction mechanism is inherent in short central compressed samples (l / b = 4). The longitudinal axis of the destroyed samples remained straight. Samples with a height of l / b = 8..10 were destroyed by another, albeit a close circuit. The general for high samples is that under the influence of the load the distortion of the longitudinal axis occurred. This leads to an uneven distribution of longitudinal deformations in sheet reinforcement, and accordingly, corrugations were formed from the side opposite to the direction of bending. But none of the centrally compressed samples collapsed from the overall stability loss.

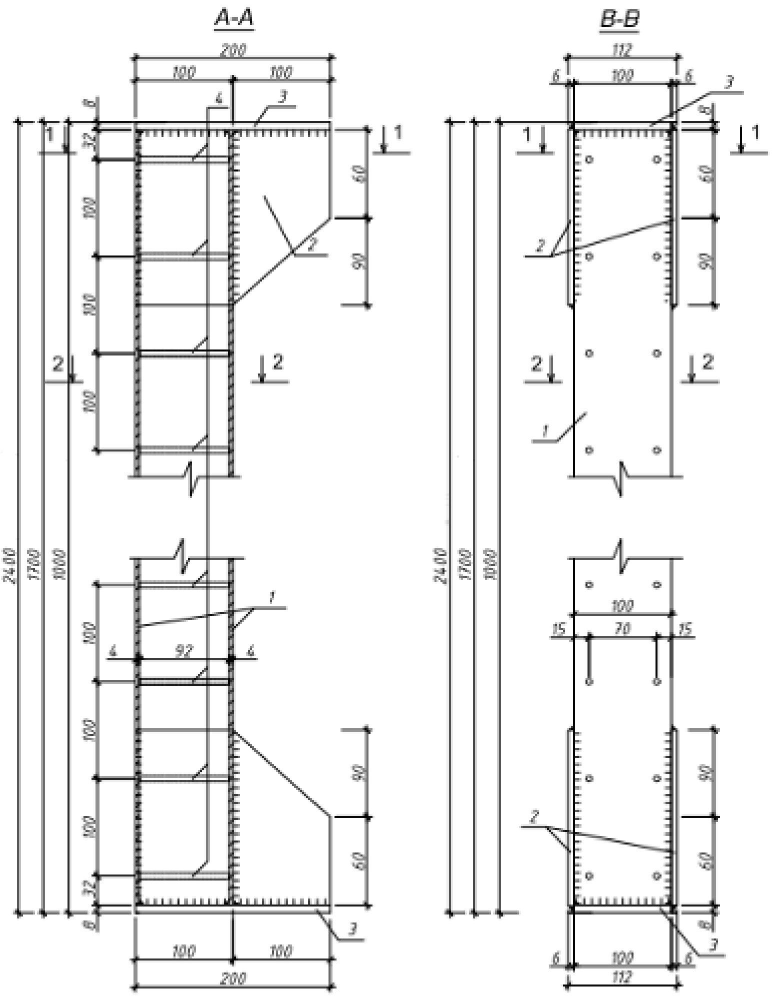

Figure 2 – Designs of experimental samples with reinforcing sheets perpendicular to the bending moment:
1 – sheet-iron plate, 2 – steel reinforcing rod, 3 – full metal, 4 – concrete

It has been established that the destruction nature of short noncentrally compressed steel-reinforced elements with sheet reinforcement depends on the magnitude of eccentricity. At an eccentricity of 1/4 of a cross-section, the mechanism of destruction is close to the destruction of centrally compressed samples, but when the the destructive force third part loading level reaches a distorted longitudinal axis. It still remains distorted until the moment of destruction.

In high noncentrally compressed steel-reinforced elements with sheet reinforcement, the curvature of the longitudinal axis was observed with the first degree of loading and increased until the time of destruction. The destruction occurred as a result of local emissions in the most compressed lane of reinforcement and simultaneous cutting of concrete. About the nature of the loss destruction samples can be judged from the photographs given in Fig. 5, 7, 9.

It should be noted that after lifting the load the longitudinal axis in all non-centered compressed steel reinforced concrete elements remained distorted and did not return to its original straight-line state. All of the above mentioned shows that the destruction of steel elements with sheet reinforcement is not brittle, as in reinforced concrete elements, and vice versa, when the load reaches a certain level, the metal elasticity limit is reached, plastic deterioration begins without reducing the loading rate.

Thus, it follows from the foregoing that for centrifugally compressed elements, as the limit, there two efforts should be taken: the first limiting effort of N_1 corresponds to the moment when the sheet of steel reinforcement is reached by the most intense fiber of the sheet strength; second N_2 is the moment of prototype destruction, where there is intense distortion of the longitudinal axis. The value of the ultimate force corresponding to the bearing capacity of the prototype is given in Table 1.

Table 1 – The bearing capacity of prototypes

Sample series	Length, L, mm	Eccentricity e_0, mm	Bearing capacity, N_1, кН	Bearing capacity, N_2, кН	N_1/N_2
SB-PD-10-1	1000	0	238	312	1,31
SB-PD -10-2	1000	25	154	198	1,29
SB-PD -10-3	1000	50	105	119	1,13
SB-PD -17-1	1700	0	234	306	1,31
SB-PD -17-2	1700	25	144	168	1,17
SB-PD -17-3	1700	50	93	105	1,13
SB-PD -24-1	2400	0	203	211	1,04
SB-PD -24-2	2400	25	138	148	1,07
SB-PD -24-3	2400	50	87	102	1,17
SB-PN-10-1	1000	0	258	319	1,24
SB-PN -10-2	1000	25	173	208	1,20
SB-PN -10-3	1000	50	108	121	1,12
SB-PN -17-1	1700	0	234	293	1,25
SB-PN -17-2	1700	25	144	168	1,17
SB-PN -17-3	1700	50	93	105	1,13
SB-PN -24-1	2400	0	184	206	1,12
SB-PN -24-2	2400	25	133	138	1,04
SB-PN -24-3	2400	50	91	94	1,03

When marking letters and figures marked: SB – samples are filled with concrete, SS – not filled with concrete; The first figure is the sample height, respectively: 10 – 1000 mm, 2 – 1700 mm, 3 – 2400 mm, the second digit is the initial eccentricity, respectively: 1–0 mm (central compression); 2–25 mm; 3–50 mm.

The test found that the experimental samples had a different bearing capacity, which depended on the constructive solution (sample height), the eccentricity of the application of the load.

The peculiarities of the work of structures with sheet reinforcement are shown by the results of testing the compressed elements shown in Fig. 3, 4, 6, 8.

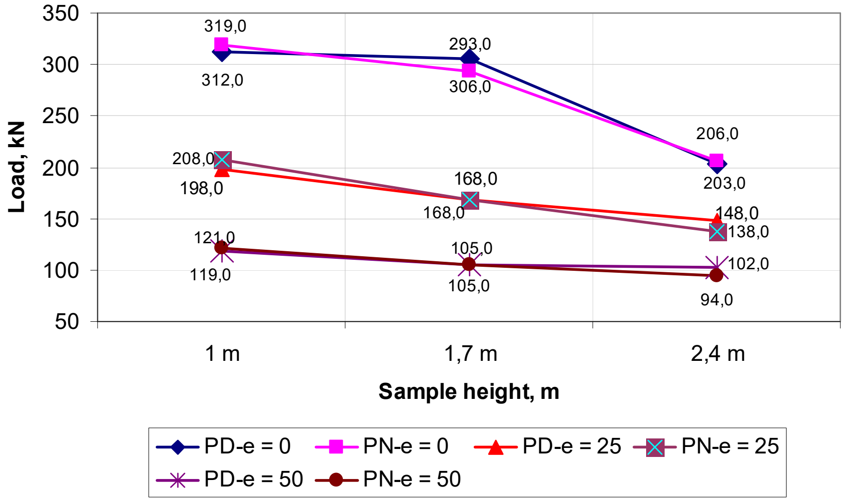

Figure 3 – Dependence of carrying capacity of tested steel-reinforced concrete samples with sheet reinforcement from element height

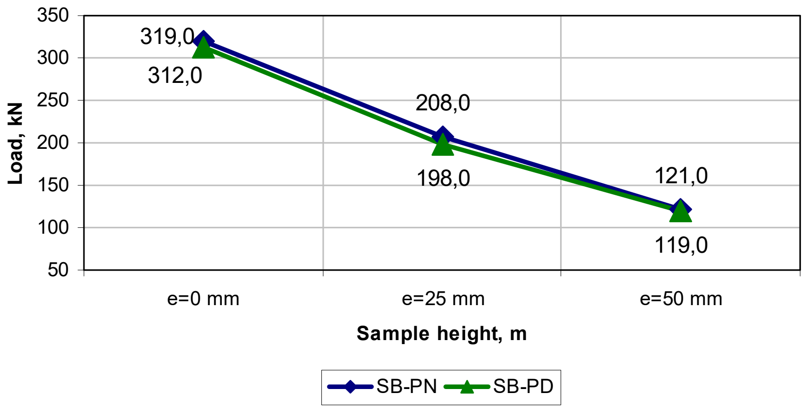

Figure 4 – Carrying capacity dependence of the tested steel-reinforced concrete samples with sheet reinforcement from the applied eccentricity at the sample height h = 1 m

Figure 5 – The destruction nature of experimental steel-concrete samples with sheet reinforcement of the series SB-PD-10-1..3 and SB-PN-10-1..3

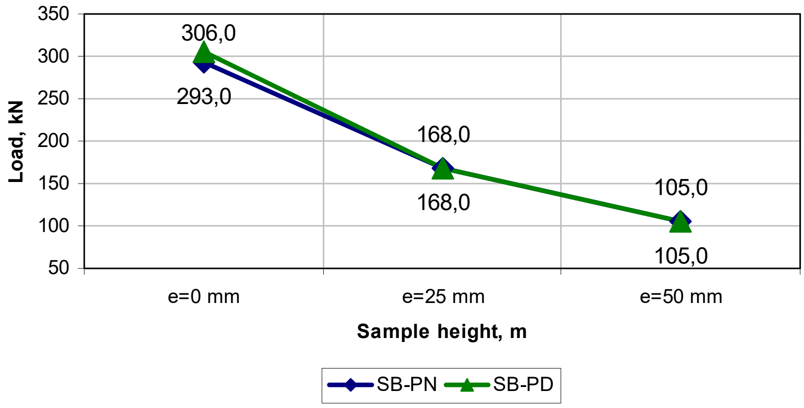

Figure 6 – Carrying capacity dependence of tested steel-concrete concrete samples with sheet reinforcement from eccentricity at samples height h = 1,7 m

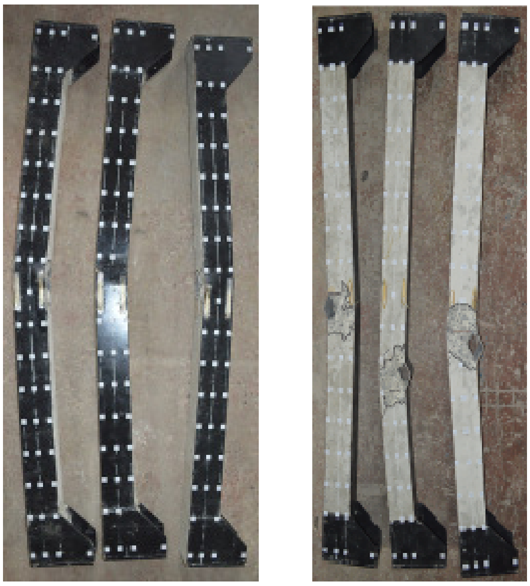

Figure 7 – The nature of the destruction of experimental steel-concrete samples with sheet reinforcement of the series SB-PD-17-1..3 and SB-PN-17-1..3

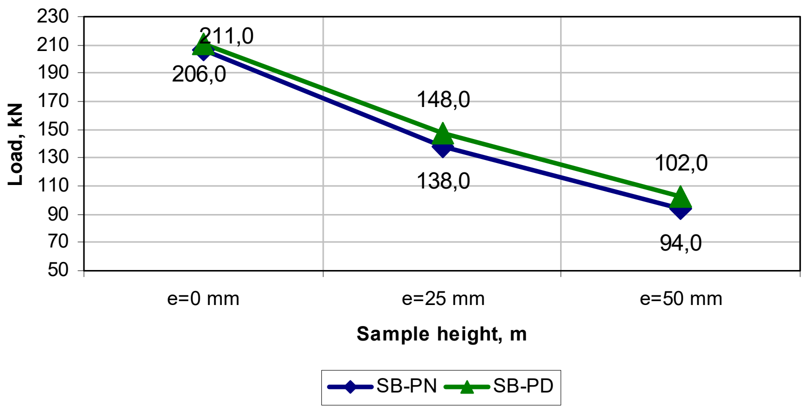

Figure 8 – Carrying capacity dependence of tested steel-reinforced concrete samples with sheet reinforcement from eccentricity at samples height h = 2,4 m

Figure 9 – The destruction of experimental steel-concrete samples with sheet reinforcement of the series SB-PD-24-1..3 and SB-PN-24-1..3 nature

The dependence of the test elements bearing capacity on their height and the applied eccentricity of the applied load is shown in Fig. 10.

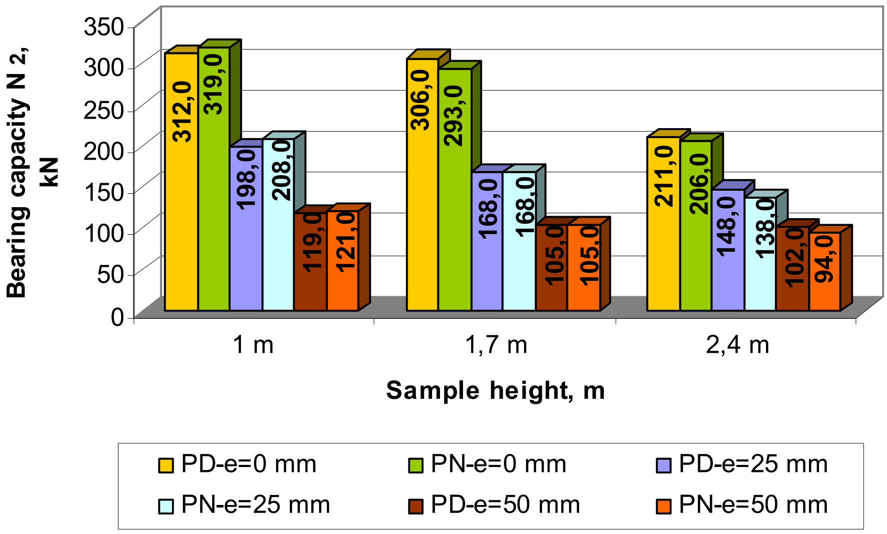

Figure 10 – Dependence of bearing capacity on the element height and applied load eccentricity

Conclusions. From the analysis of the above graphs it can be seen where extent the element height and the eccentricity of applying load are influenced by the bearing capacity of the compressed steel reinforced concrete elements with sheet reinforcement. The bearing capacity of the elements at an increase in height from 1m to 2,4 m was reduced by 35,4% with central compression, by 33,7% at center-centered compression with eccentricity of 25 mm and by 22,3% with centrifugal compression with an eccentricity of 50 mm. The bearing capacity of the tested samples practically does not depend on the location of the sheet reinforcement: in the plane or perpendicular to the plane of the operating moment. At different altitudes of the tested elements and different eccentricities, the difference between their carrying capacity was 0 – 5%.

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