COMPARISON OF RESULTS OF EXPERIMENTAL RESEARCH OF FLEXIBLE ROD COMPOSITE REINFORCED CONCRETE STRUCTURE WITH SHEET STEEL FRAMEWORK

Storozhenko Leonid[1,a], Murza Sergii[2,b], Beznigaev Mykyta[3,c], Efimenko Olena[4,d]
[1] Poltava National Technical Yuri Kondratyuk University
[2] Poltava National Technical Yuri Kondratyuk University
[3] Poltava National Technical Yuri Kondratyuk University
[4] Poltava National Technical Yuri Kondratyuk University
[a] s_murza@mail.ru, [b] s_murza@mail.ru, [c] best.niko@yandex.ua, [d] lenysia_17@mail.ru

Summary

The article shows the main results of experimental research flexible rod composite reinforced concrete structure with sheet steel framework. When conducting experimental studies of researched the peculiarities of constructions under load and nature loss bearing capacity composite reinforced concrete structure samples with external steel framework with steel plates depending on the eccentricity application of efforts. Common to all samples is that under load was hogging the long axis of the element. This led to an uneven distribution of longitudinal deformations in reinforcement sheet, and accordingly, the wrinkles were formed by the opposite direction of bending. The results showed that the compressed-noncentral elements as limiting load advisable to take two values: the first corresponds to the limit efforts to achieve the most intense fiber sheet reinforcing fluidity limits of steel; second – the moment destruction test sample in which there is intense curvature of the longitudinal axis.

Key words: composite reinforced concrete structure, flexible structure, rod structure, experimental research.

1. Introduction

Along with reinforced concrete for over a hundred years used composite reinforced concrete structure designs that combine reinforced concrete and steel rolling profiles. These structures are extremely diverse, they are used in the construction of bending and compressed structures, plates, and they are used in the construction of various buildings.

Composite reinforced concrete structures are widely used around the world. Already proven that their efficient use for overlapping large spans (slabs, beams, girders, frame work, etc.), column that accept heavy loads (columns of industrial and civil buildings, supports for various purposes, electric poles, etc.), in engineering structures. Cross section of these structures can be varied. When using composite reinforced concrete structure reduces the mass of buildings is often possible to do without formwork, embedded parts. Such structures have many advantages, the main one – is the lack of formwork, the ability to produce complex structures, which together work reinforced concrete and steel profiles.

2. Literature overview

Composite reinforced concrete rod structure extremely diverse: it supports and columns, beams and girders, plates and ceiling coverings, spatial design. They are used in the construction of bending and compressed designs, they are used in the construction of various structures [7]. The use of steel profiles, sheet reinforcement as given reinforcement in compressed-curved structures can reduce costs formwork, reduce weight structures, simplify the construction of columns, monolithic and modular coverings buildings and constructions [5].

At present gained extensive experimental and theoretical experience on the research of flexible compressed composite reinforced concrete structure. Different authors at different times suggested a number of methods for calculating such elements. Worthy of special attention experimental research conducted by the authors [1–7]. Based on the results obtained, which composite reinforced concrete structure have increased durability and resistance compared with steel. However, the results of the calculation of the bearing capacity of flexible compressed elements received different. Moreover, the greater flexibility and the greater the initial eccentricity application of the load, the greater the difference of the results.

The external armature in a steel sheet allowing efficient use reinforced concrete structures with a large percentage of reinforcement with limited size section. These structures have significant advantages in the design and construction of various buildings. The results of many experiments [2, 4, 5–8] established that at the time of exhaustion bearing capacity of steel concrete structural elements are not destroyed fragile, unlike reinforced concrete. The constructive form steel reinforcement differently affects the mechanism of achieving the ultimate state bearing element is made from composite reinforced concrete structure.

The article aims to analyze of experimental research of flexible rod composite reinforced concrete structure with sheet steel framework depending on eccentricity application of load.

3. Test methods

Based on the review of papers [1–8] and the development program of experiments was tasked to experimentally determine the strength and characteristics of work under loading compressed rod elements of reinforcement sheet, receive the characteristic parameters of stress-strain state for further analysis of the stability of this class of structures. To produce experimental samples used steel sheet t=4 mm, the transverse reinforcement of class A-I ø6 mm, longitudinal reinforcement is missing. The height of the samples was 1000–2400 mm, section 100x100 mm.

a) b)

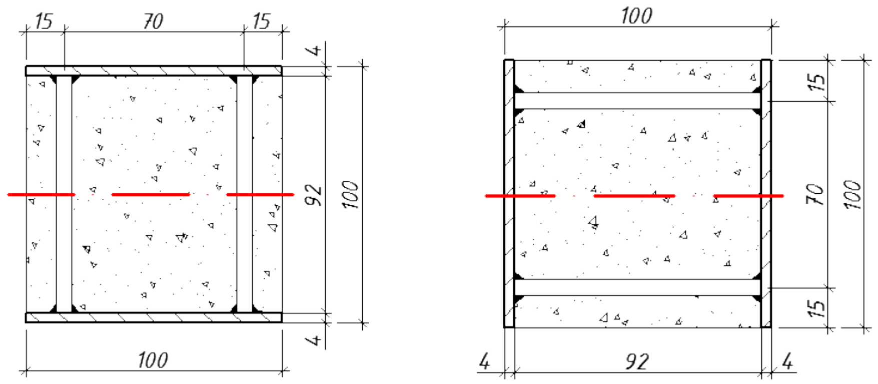

Figure 3.1. Cross-sectional of experimental designs

a) design of reinforced steel plates in the plane tangential to the plane of application of eccentricity; b) design of reinforced steel plates in the plane normal to the plane of application of eccentricity

For detection efficiency composite reinforced concrete structure elements tested samples of steel, without concrete the same size. To determine the physical and mechanical properties of concrete filler tested standard concrete cubes 150x150x150 mm and prisms 150x150x600 mm, made of the same concrete as the prototypes.

4. Results and their presentation

Based on this problem for the experiment were designed cross sections of test samples and location of their reinforcement. The object of experimental research was to determine the characteristics of work under loading and the nature of the loss of the bearing capacity composite reinforced concrete structure samples the external reinforcement steel plates depending on the eccentricity of application of efforts, and compare the features of work, compressed elements with a different arrangement of reinforcement sheet (as tangential planes and normal planes application of eccentricity) fig 4.1.

Experimental samples composite reinforced concrete structure rod structures consist of a sheet of longitudinal reinforcement, transverse reinforcement rods, face metal plates, Traverse and filler (concrete). Face plates and transverse rods interconnect the longitudinal reinforcement tape, which performs both the function of formwork. Transverse reinforcement with rods welded at a distance 100 mm from each other. During concreting welded in the form box, the sheets are interconnected by means of rods placed on the prepared surface and filled with concrete in a horizontal position. Compaction of concrete mix was performed using vibrators. Making concrete conducted on concrete factory site. Welded joints performed semi-automatic arc welding. Transverse reinforcement rods were welded perpendicular to the sheet reinforcement semiautomatic welding. The transverse rods placed along two rows with minimal protective layer.

a) b)

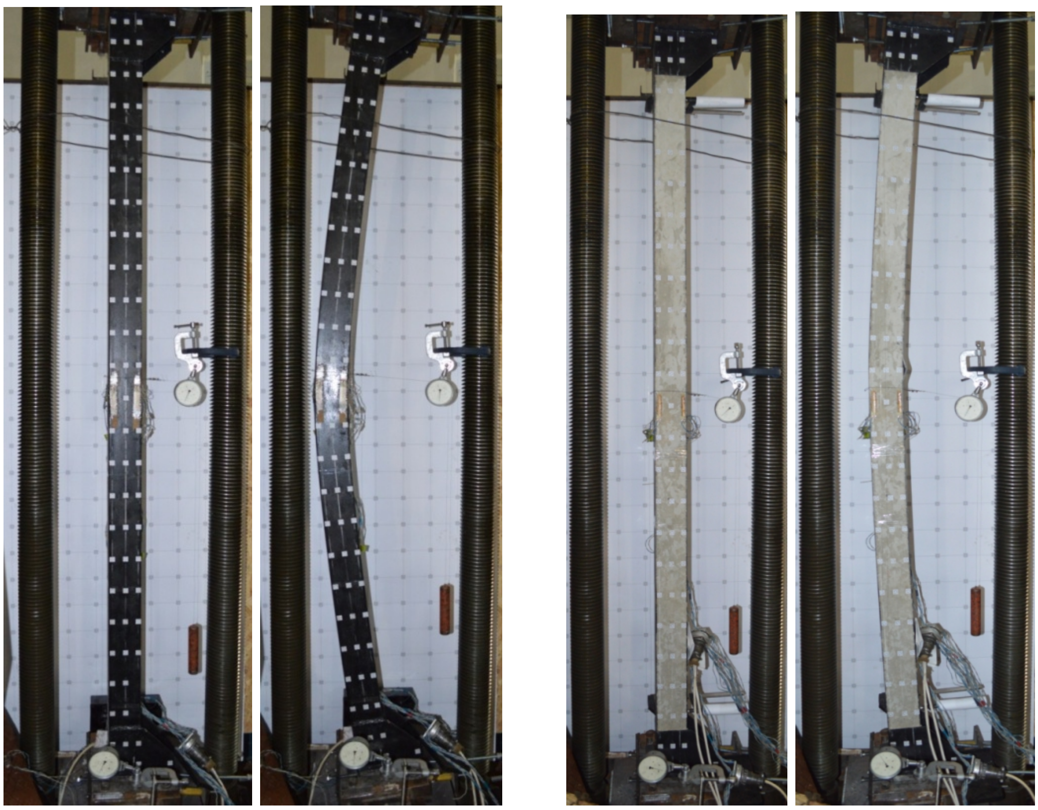

Figure 4.1. General view samples

a) design of reinforced steel plates in the plane tangential plane eccentricity application of load; b) design of reinforced steel plates in the plane normal to the plane of eccentricity application of load

Elements filled with concrete in a horizontal position on the vibro-table. Time vibration for composite reinforced concrete structure and concrete samples T = 5–10 sec. The first 5 – 28 days exposed surfaces of concrete experimental samples were wet and covered with a layer of sawdust for moisture retention, after which the samples were stored before testing in the laboratory.

The temperature in the room where made and saved experimental samples equal T = 15-17 ^{0}C and relative humidity 70-75%. After the concreting samples were painted two times by refinishing for observation appearance of Chernov lines. The testing of sample is held at 28 days or more. Loading stepwise (0,05 – 0,1) from N destroying. The load was applied by knife hinges. Longitudinal deformation measured by means of electrical strain gauges at all stages of loading. Exposure time at each stage was 5-10 min., required for readout (Fig.4.1).

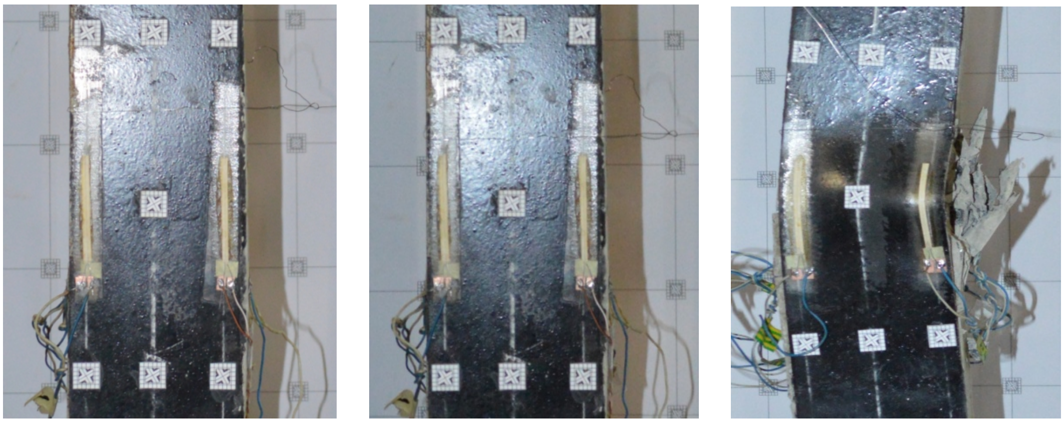

Figure 4.2. Fracture prototypes of reinforced steel plates in the plane tangential to the plane of eccentricity application of load

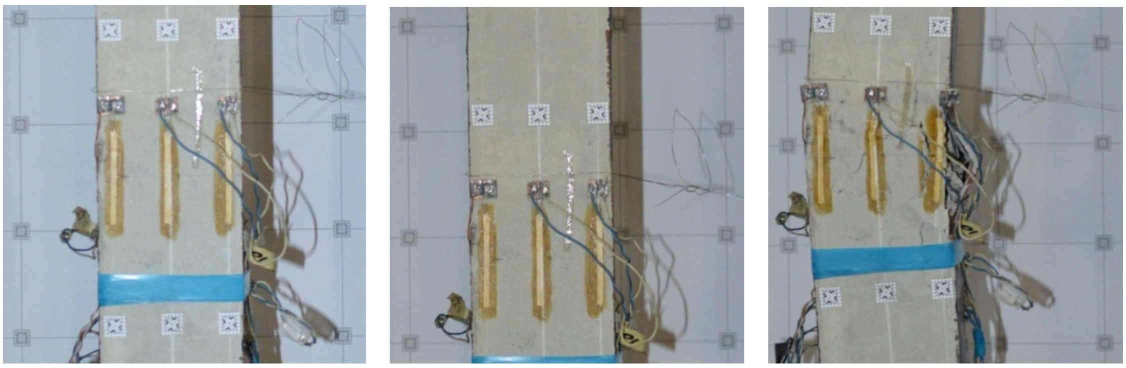

Figure 4.3. Fracture prototypes of reinforced steel plates in the plane normal to the plane of eccentricity application of load

To determine the data on rotation angles and position the axis of the deformed elements used photogrammetric method. When using photogrammetric method [3] on the sides of experimental designs were pasted markings size 1,5 x 1,5 cm [1] (fig. 4.2, 4.3.). Taking photos was performed at each stage of loading, photo shooting automatically activated on your PC. This method makes it possible to obtain accurate data moving markings, except for occasional movement of the camera and all components photogrammetric method. For the possibility of consideration of external orientation elements were used stand with image control grid is by design. Coordinate horizontal and vertical grid lines printed in increments of 10 cm overlap at points located at the intersection where the control markings size 1,5 x 1,5 cm.

Fracture of composite reinforced concrete structure elements, with sheet reinforcement observed when the longitudinal deformation equal, border fluidity metal (ε=200..300), on refinishing coating formed of grid as lines Chernova (fig. 4.4, 4.5).

Figure 4.4. The value destroying the efforts being tested prototypes of reinforced steel plates in the plane tangential to the plane of eccentricity application of loading

On the surface of the concrete free of sheet reinforcement, microcracks in the united macrocrack. The direction of these crack coincides with the longitudinal axis of the test sample.

Figure 4.5. The value destroying the efforts being tested prototypes of reinforced steel plates in the plane normal to the plane of eccentricity application of loading

Further occurred deformation reinforcement sheet due to pressure of concrete in the transverse direction with the formation of corrugated perpendicular to the longitudinal axis, the area between adjacent rows cross clamps. Increased loading leads to destruction, by breaking clamps and breach concrete monolith. Concrete destroyed and broken up in the direction of free sheet reinforcement.

5. Discussion

Common to all the designs is what occurred under loading distortion longitudinal axis element. This led to an uneven distribution of longitudinal deformations in reinforcing sheet, and accordingly, corrugations been arising with the opposite direction of the bend. The results showed that the compressed noncentral elements values bearing capacity for test samples reinforced with steel plates in the plane tangential to the application of eccentricity plane under loading differed to 10% compared with samples of reinforced steel plate's reinforced plane normal to the plane of eccentricity application of load. The destruction of composite reinforced concrete structure reinforced sheet is not fragile, like concrete elements, but rather when loading reaches a certain level, the reinforcing sheet, achieved yield strength of metal, begins plastic destruction without reducing load.

6. Conclusions

Determined that fracture short noncentral compressed composite reinforced concrete structure elements, with sheet reinforcement depends on the eccentricity. When eccentricity 1/4 in cross-section (25 mm) mechanism of destruction similar to the destruction of central compressed samples, but when you reach the level of loading of 0.25 destroying effort starts distorted longitudinal axis. It remains distorted until the moment of destruction. In noncentral compressed composite reinforced concrete structure elements, with sheet reinforcement at eccentricity in 1/2 cross-section (50 mm) distortion longitudinal axis observed from the first degree of loading and increased the time of destruction. The destruction occurred due to local deformation, the most compressed reinforcement strip and simultaneous deformation of concrete. Should be noted that after removing the longitudinal axis loading all noncentral compressed composite reinforced concrete structure elements reinforced with sheet remained distorted and not returned before its original state.

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