1. Розроблено програмний комплекс, який реалізує методику Єврокод за розрахунком ефективних геометричних характеристик стиснутих ЛСТ профілів С- і Z-образного перерізу.

2. Досліджено емпіричні залежності геометричних характеристик ефективних перерізів холодноформованих сталевих профілів від їх параметрів.

3. Розроблена спрощена інженерна методика попереднього розрахунку ефективних геометричних характеристик ЛСТ профілів С-подібного перерізу при згині у всіх напрямках. Максимальні відхилення отриманих співвідношень ефективного моменту опору до теоретичних значень складали від +5% до -32,4%.

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АНАЛІЗ ЕКСПЕРИМЕНТАЛЬНОГО ДОСЛІДЖЕННЯ ЗАЛІЗОБЕТОННИХ БАЛОК З ВИНЕСЕНИМ РОБОЧИМ АРМУВАННЯМ НА ЗГИН

АНАЛИЗ ЭКСПЕРИМЕНТАЛЬНОГО ИССЛЕДОВАНИЯ ЖЕЛЕЗОБЕТОННЫХ БАЛОК С ВЫНЕСЕННЫМ РАБОЧИМ АРМИРОВАНИЕМ НА ИЗГИБ

ANALYSIS OF EXPERIMENTAL INVESTIGATION CONCRETE BEAMS WITH WORKING REINFORCEMENT CARRIED OFF ON A BEND

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Наведено результати експериментальних досліджень залізобетонних балок з винесеним робочим армуванням,розроблено методику проведення експерименту, отримано дані щодо несучої здатності, деформацій і характеру руйнування досліджуваних зразків.

Представлены результаты экспериментальных исследований железобетонных элементов с вынесенным армированием, разработана методика проведения эксперимента, получены данные о несущей способности, деформациях и характере разрушения исследуемых образцов.

The results of experimental researches of reinforced concrete beams with reinforcement work rendered, developed the method of the experiment, obtained data on bearing capacity, deformation, character of destruction and fracture samples.

Ключові слова:
залізобетон, балка, винесене робоче армування, експериментальне дослідження.
железобетон, балка, вынесенное армирование, экспериментальное исследование.
reinforced concrete, beam, rendered reinforcement, experimental research.

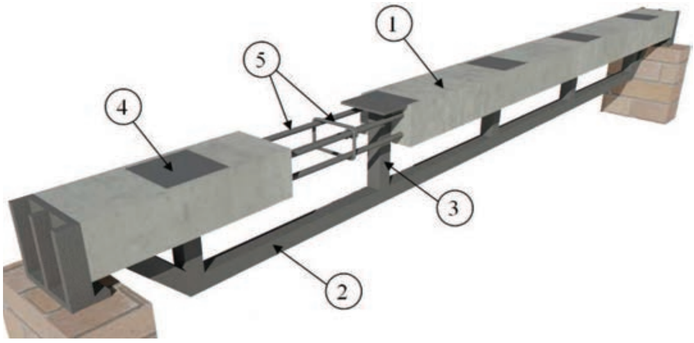
Introduction. Modern building is characterized by using new types of structures. Search for new kinds of combinations of steel and concrete is prospective direction, which saves material and creates a new class of building structures that differ in as in the structural characteristics, and the degree of utilization of the factors collaborative work of both materials. New types of constructions require experimental research related to the study of their bearing capacity, deformation and fracture.

Review the latest sources of research and publications. Based on the analysis of recent trends in the reinforced concrete structures rendered reinforcement [1] and Patent situational studies [2] it was reported that concrete constructions reinforced with rendered are widely used throughout the world [3, 4]. Is already proved their rationally using for covering large spans (slabs, beams, girders, trusses, etc.) as a rack which withstands the heavy loads (columns of industrial and civil buildings, supports various purposes, electric poles etc.) in engineering structures. Cross-section of these structures can be extremely varied, some have already experimentally investigated [5].

Tagging is not resolved before the general problem. The analyzed volume of information sources gave positive results in finding articles and research papers on the analysis of experimental studies the authors proposed sections of reinforced concrete beams with reinforcement rendered. Also not fully elucidated fracture and impact of external factors on constructions.

Problem statement. As a result of work it is necessary to develop a methodology the experiment to obtain the necessary experimental data on carrying capacity, deformation and fracture samples, obtaining a clear picture of how strains in cross-section, and in the area of the transverse forces and bending moments, make sure that such reliable construction in operation and exploitation and can be used in industrial and civil construction.

Basic material and results. The essence test samples (Pic. 1), consists in a constructive solution of the cross-section, made using steel pipe (2), which is together with the linear part of reinforced concrete structures (1) is made of concrete class C32/40 size 120x80mm. Compatibility of concrete and steel is ensured by the connection of the upper and lower belt of steel pipes (3) are welded to the steel plates (4) size 100x100x8mm. Additional concrete belt reinforced with reinforcing mesh (5). When hardening concrete firmly adheres with the elements of metal frame creating a single structure, and under the influence of external forces the top and bottom belt working together. Samples were tested at achieving concrete project strength, but not earlier than 28 days after steaming. Before testing the metal surface samples purified from the influx of concrete and covered with varnish for two times. Tests conducted on Amsler's press capacity of 60 tons with manual transmission.



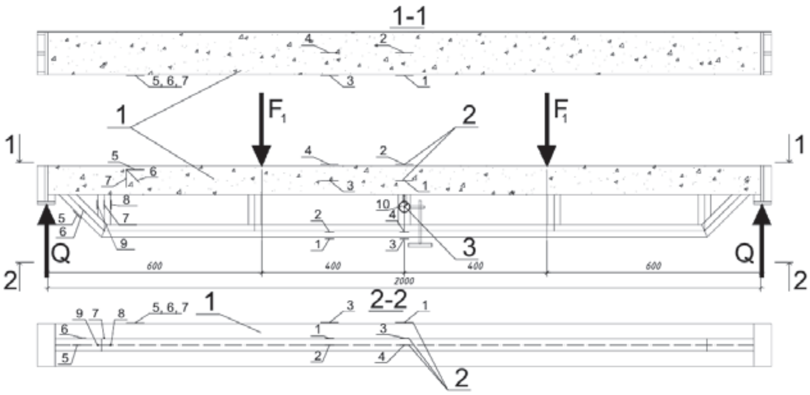
Pic. 1. A general view of the sample

1 - linear reinforced concrete construction; 2,3 - pipes; 4 - anchors; 5 - reinforcing mesh

During the experimental researches measured the deformation outer surface of metal components and concrete in most intense section of the fibers. Deformation of metal components were measured using strain gauge type 20 – 200 V, outer surface of concrete using strain gauge type 50 – 325 V. Countdown for strain gauge were removed using a multichannel measurement system for strain-gauge static tests (pic. 2).

Pic. 2. Multichannel measuring tensometric system for static tests

Layout of instrumentation for the study of the normal cross section (pic. 3).



Pic. 3. Scheme of strain gauges during testing the sample

1 - sample; 2 - strain gauge; 3 - deflectometer

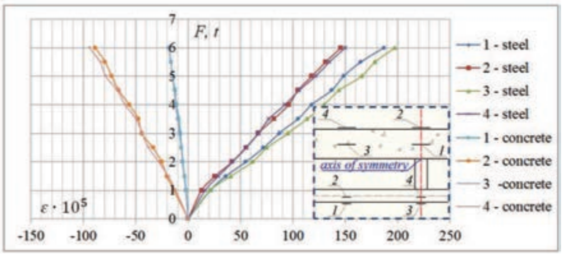
According to the accepted methodology of experimental researches trials conducted on pure bending.

During researches of normal sections of experimental samples under the influence of normal load was marked the development of cracks in concrete, with increasing load until happened a critical fracture of concrete shelf and there was a fluidity steel component. Also was recorded an increase in the intensity of the deflection at the beginning of the beam in the plastic stage.

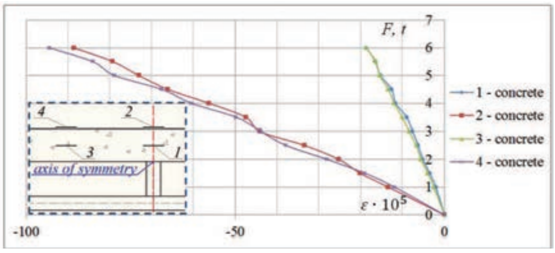
As a result, the measurement of displacements in the middle of the span and the occurrence of microcracks in the extreme fibers of the samples by using indicators such as clock, deflectometer and strain gauge received graphs of dependence of strain on the load. In the middle of the span were placed gauges - strain gauge, fittings and pasted on the shelf, deflectometer to determine deflections. The graphics depending on the load deformation (pic. 4 – 11).

From the above graph shows that at the initial stage of loading occur mainly elastic deformation. At these load levels, which correspond to deformations in which there is fluidity and the formation of cracks on the concrete shelf, there is a loss of carrying capacity of the sample.

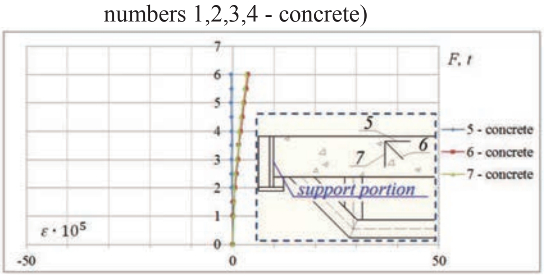
In general, the beam at all stages of loading worked as a single monolithic structure. On (pic. 9 - 10) shows the distribution of force deformation height of normal cross section of the samples.



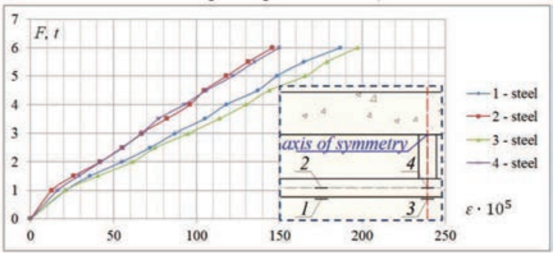
Pic. 4. The deformations in the normal section measured electrical strain gauges located on the vertical interval



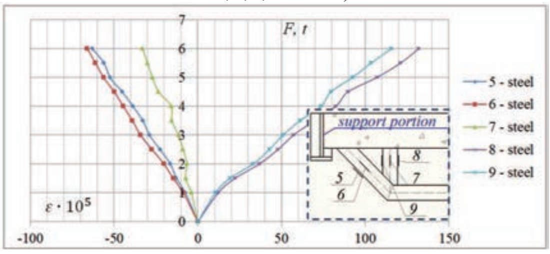
Pic. 5. Deformations of the beam measured electrical strain gauges (strain gauges numbers 1,2,3,4 - concrete)



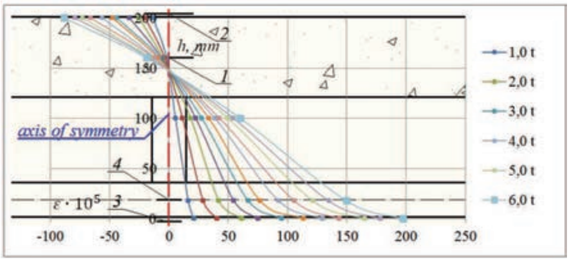
Pic. 6. Deformations of the beam measured electrical strain gauges (strain gauges numbers 5,6,7 - concrete)



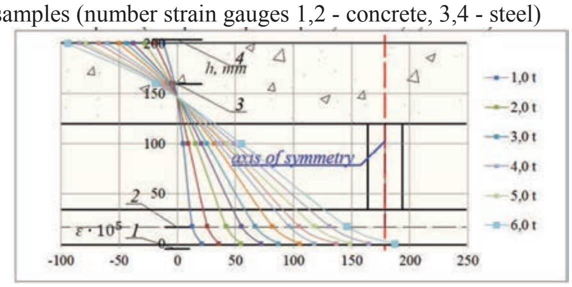
Pic. 7. Deformations of the beam measured electrical strain gauges (strain gauges numbers 1,2,3,4 - steel)



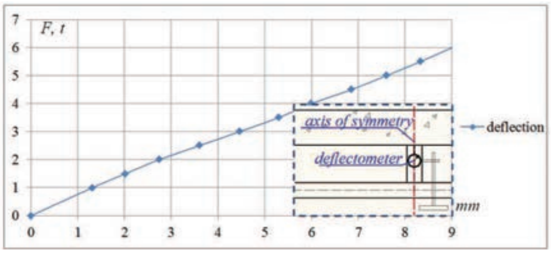
Pic. 8. Deformations of the beam measured electrical strain gauges (strain gauges numbers 5,6,7,8,9 - steel)



Pic. 9. Diagrams of deformation distribution along the height of normal cross section of samples (number strain gauges 1,2 - concrete, 3,4 - steel)



Pic. 10. Diagrams of deformation distribution along the height of normal cross section of samples (number strain gauges 3,4 - concrete, 1,2 - steel)

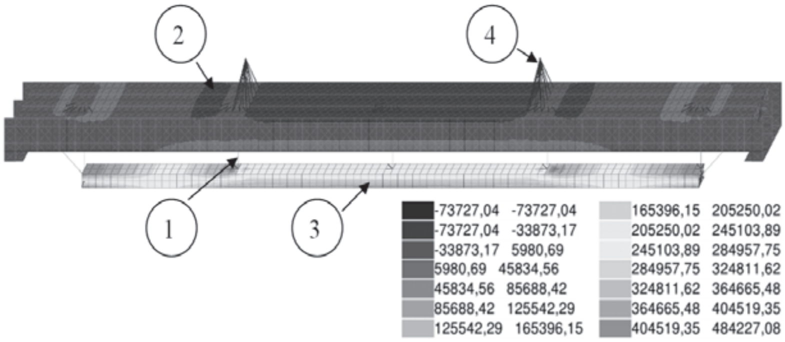


Pic. 11. The dependence of the the deflection of the load measured by deflektometer

When the beam deformation (pic. 5 – 10) observed elastic reinforcement and concrete work to achieve 75% of the damaging loads. Upon reaching loads greater than 75% of the damaging began to emerge a significant crack in concrete shelves due to what happened in the middle of the complete destruction of the samples. Cracks observed at the place applying the load F_1, which was the highest moment and shear force. Destination crack growth was observed on the place of application of force F_1 at an angle to support response Q.

For loads that met the devastating $M \leq Mu$ began to observed significant deformation of the beam, the deflection reached the limit state, then beam lost its load carrying capacity. Brittle fracture specimens was not observed, but rather held plastic, which is typical for steel structures. In general, the studied beam at all stages of loading worked as a single monolithic structure.

To compare the results create a calculation scheme in programming complex SCAD. Design scheme is defined as a system of common species are mostly unknown linear motion units along the axes X, Y, Z and rotations around these axes.



Pic. 12. Stress Distribution N_x (kN/m^2) at loading 6t

1 – rods; 2 - three-dimensional elements; 3 – plates; 4 - perfectly rigid body (PRB)

Design scheme reinforced concrete beam with work rendered reinforcement (pic. 12) has the form of a three-dimensional model and consists of the finite elements: 1) rods - connects the lower and upper belt of the proposed construction, parametric section 35x35mm with wall thickness of 2 mm with conventional steel; 2) three-dimensional elements - modeling concrete component of the upper zone of rigidity concrete class C32/40; 3) plates - model the steel pipe in the lower section of the belt 35x35mm with wall thickness of 2 mm ordinary steel; 4) perfectly rigid body (PRB) - modeling anchors located in a concrete component, place of welding elements metal frame and places of transfer efforts on construction. The obtained data give a middle convergence of 12% with results obtained during the experiment.

Conclusions. Reinforced concrete beam with rendered working reinforcement at all stages of worked as a single monolithic construction. Methodology and measuring devices can get the necessary experimental data on carrying capacity, deformation and fracture samples. Used for the experiment measuring devices strain gauge, deflectometer can get detailed information about the deformation of samples at any time of the load and get a clear picture of how strains in cross-section, and in the area of the transverse force and bending moment. The distribution of longitudinal deformation on the height of the crosssection at almost all stages of the stress-strain state is close to linear, which allows the use in the calculation of the hypothesis of plane sections. Comparison of the results of the experimental and numerical calculations implemented in software complex SCAD showed greater convergence results and proved the feasibility of counting data construction according to the methods. The experimental results indicate that these constructs reliable in operation and exploitation and can be used in industrial and civil construction.

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