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ABOUT THE METHODOLOGY OF EXPERIMENTAL INVESTIGATION OF THE DAMAGES INFLUENCE ON THE STRESS-STRAIN STATE AND THE RESIDUAL BEARING CAPACITY OF THE INCLINED SECTIONS OF REINFORCED CONCRETE BEAMS

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Abstract. The article reports on the developed technique for conducting the experimental studies to determine the effect of concrete damages in compressed zone of rectangular cross-section reinforced concrete beams on their stressed-strain state and the residual bearing capacity of inclined sections with the formulation of studies using the mathematical method of experiment planning. In according to the experiment planning matrix, 15 samples of reinforced concrete beams were fabricated. The dimensions of the beams are 100×200×1200 mm and the working span is 1000 mm. In the beams the artificial damages of the compressed zone of concrete are laid in advance in different sizes, the different size of the shear span are also used. Materials for beams: concrete – grade C25/30; working longitudinal reinforcement – Ø18 mm of grade A500C; constructive longitudinal reinforcement and transverse reinforcement – Ø6 mm of grade A400C. To measure the deformations of reinforcement and concrete, strain gauges with a base of 10 mm for the steel reinforcement and 50 mm for the concrete are used. To determine the physical-mechanical properties of materials, control samples of cubes and prisms were selected.

Keywords: reinforced concrete beams, damages in reinforced concrete, destruction, inclined section, residual bearing capacity, deformations.

ПРО МЕТОДИКУ ЕКСПЕРИМЕНТАЛЬНОГО ДОСЛІДЖЕННЯ ВПЛИВУ ПОШКОДЖЕНЬ НА НАПРУЖЕНО-ДЕФОРМОВАНИЙ СТАН ТА ЗАЛИШКОВУ НЕСУЧУ ЗДАТНІСТЬ ПОХИЛИХ ПЕРЕРІЗІВ ЗАЛІЗОБЕТОННИХ БАЛОК

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Анотація. В даній статті представлено розроблену методику проведення експериментальних досліджень для визначення впливу пошкоджень бетону стиснутої зони в залізобетонних балках прямокутного перерізу на їх напружено-деформований стан та залишкову несучу здатність за похилими перерізами з постановкою дослідів за допомогою застосування математичного методу планування експерименту. Відповідно до матриці планування експерименту було виготовлено 15 зразків залізобетонних балок класу бетону С25/30 з розмірами 100×200×1200 мм та робочим прогоном 1000 мм із заздалегідь закладеними різних розмірів штучними пошкодженнями стиснутої зони бетону та різною величиною прогону зрізу.

Ключові слова: залізобетонні балки, пошкодження залізобетону, руйнування, похилий переріз, залишкова несуча здатність, деформації.

О МЕТОДИКЕ ЭКСПЕРИМЕНТАЛЬНОГО ИССЛЕДОВАНИЯ ВЛИЯНИЯ ПОВРЕЖДЕНИЙ НА НАПРЯЖЕННО-ДЕФОРМИРОВАННОЕ СОСТОЯНИЕ И ОСТАТОЧНУЮ НЕСУЩУЮ СПОСОБНОСТЬ НАКЛОННЫХ СЕЧЕНИЙ ЖЕЛЕЗОБЕТОННЫХ БАЛОК

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Аннотация. В данной статье представлено разработанную методику проведения экспериментальных исследований для определения влияния повреждений бетона сжатой зоны в железобетонных балках прямоугольного сечения на их напряженно-деформированное состояние и остаточную несущую способность наклонных сечений с постановкой исследований с использованием математического метода планирования эксперимента. В соответствии с матрицей планирования эксперимента было изготовлено 15 образцов железобетонных балок класса бетона С25/30 с размерами 100×200×1200 мм и рабочим пролетом 1000 мм с заранее заложенными разных размеров искусственными повреждениями сжатой зоны бетона и разной величиной пролета среза.

Ключевые слова: железобетонные балки, повреждения железобетона, разрушение, наклонное сечение, остаточная несущая способность, деформации.

Introduction. In our country, due to the actual economic conditions, the vast amount of concrete structures operated with considerable exploitation terms. Evaluation of residual bearing capacity of damaged concrete elements is one of the most important issues nowadays and therefore requires experimental and theoretical studies [1], it may help to develop a methodology for assessment of residual bearing capacity. Development of such methods will reduce capital investment costs of materials, deadlines and human resources during the repair and renovation of existing buildings. The complexity of developing such methods is that the effect of the force plane coincides with the main axis, but due to the formation of concrete damages in the compressed zone its main axis shifted and oblique bending occurs [2].

Analysis of recent research and publications. A series of experimental studies were conducted at the Odessa State Academy of Civil Engineering and Architecture, [3, 4, etc.]. For the development of research program authors used mathematical experiment planning [5]. Through its usage most relevant and accurate results with a minimum number of experimental tests are achieved. After analyzing the literature sources [6, 7] as factors which may affect the function, output relative shear span, depth damaging side faces beam in the compressed zone of concrete and the angle of beam damage to the sides in the compressed area, were selected .

The purpose of the work. To develop a method of experimental study, which will help to assess the impact of damages in reinforced concrete beams on their stress-strain state and residual bearing capacity of inclined sections.

Main part. To determine the stress-strain state and residual bearing capacity of inclined sections rectangular reinforced concrete beams the method of research using mathematical planning experiment was developed at the Department of Building Structures at Odessa State Academy of Civil Engineering and Architecture.

Single-span freely-supported concrete beams measuring 100×200×1200 mm with 1000 mm working span were made. Materials for the production of used beams are: concrete – grade C25/30; longitudinal working steel reinforcement – 2 bars Ø18 mm of grade A500C and welded on its ends to provide anchoring reinforcing short-bars Ø10 mm of grade A400C, mounting longitudinal reinforcement – 2 bars Ø6 mm of grade A400C, transverse reinforcement in the form of clamps – Ø6 mm of grade A400C with distance of 175 mm in part beams within a shear span and 100 mm in the rest part of the beams. Mounting hinge fittings are made of bars Ø3 mm of grade B500. Steel reinforcement bars are combined in a knitted frame using knitting wire. At the ends of longitudinal working bars reinforced short-bars to ensure reliable anchoring were welded. Scheme of reinforced bars are shown in Fig. 1. For the measuring strain of bars within the shear span, on the surface of transverse reinforced bars strain gauges with a base of 10 mm were glued using the two-component adhesive glue «MitreFix». To measure the deformation of concrete beams on the surface of concrete strain gauges with a base of 50 mm were glued using glue BF-2.

Development of methods was carried out using complex mathematical statistics methods – experimental design. According to this 15 prototypes for the three-tier three-factorial experiment will yield reliable results and maximum accuracy with a minimum number of performed experiments were produced. Matrix experimental planning is shown in Table. 1.

Factors that are selected for experiment planning matrix is – relative shear span (*a/d*); the depth of damage a_1 side faces beam in the compressed zone of concrete; injury angle β. To simulate damage in beams liners with polystyrene plates were put in.

For determination of physical and mechanical properties of concrete 3 samples cubes 150×150×150 mm and 6 samples prisms 150×150×600 mm were made according to [8, 9] and for determination of physical and mechanical properties of reinforcing steel bars 3 samples each diameter rods each class were selected according to [10].

Table 1 – Matrix experimental design

No	Beam designation	The coded values of factors			The natural values of factors		
		X_1	X_2	X_3	relative shear span *a/d* (c, mm)	the depth of damage a_1/h, mm (a_1, mm)	corner damage β/ 90° (β, °)
1	Б1	+1	-1	-1	3c (510)	0 (0)	0 (0°)
2	Б2	+1	0	0	3c (510)	0.25 (50)	1/3 (30°)
3	Б3	+1	0	+1	3c (510)	0.25 (50)	2/3 (60°)
4	Б4	+1	+1	-1	3c (510)	0.5 (100)	1/3 (30°)
5	Б5	+1	+1	+1	3c (510)	0.5 (100)	2/3 (60°)
6	Б6	0	-1	-1	2c (340)	0 (0)	0 (0°)
7	Б7	0	0	0	2c (340)	0.25 (50)	1/3 (30°)
8	Б8	0	0	+1	2c (340)	0.25 (50)	2/3 (60°)
9	Б9	0	+1	-1	2c (340)	0.5 (100)	1/3 (30°)
10	Б10	0	+1	+1	2c (340)	0.5 (100)	2/3 (60°)
11	Б11	-1	-1	-1	c (170)	0 (0)	0 (0°)
12	Б12	-1	0	0	c (170)	0.25 (50)	1/3 (30°)
13	Б13	-1	0	+1	c (170)	0.25 (50)	2/3 (60°)
14	Б14	-1	+1	-1	c (170)	0.5 (100)	1/3 (30°)
15	Б15	-1	+1	+1	c (170)	0.5 (100)	2/3 (60°)

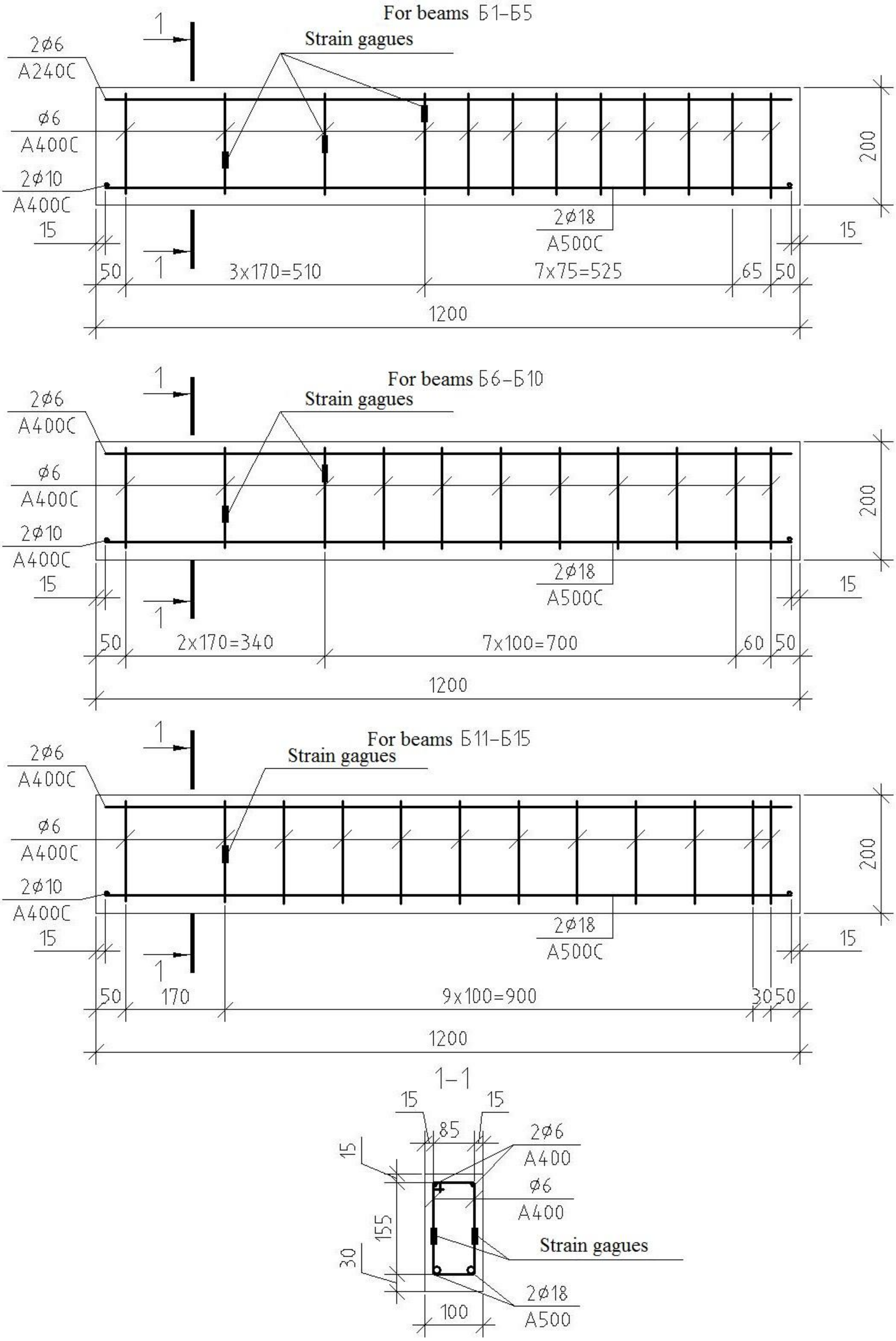

Fig. 1. Scheme of reinforcing bars in prototypes and glued strain gagues

The main conclusions and recommendations for further research:

1. Accepted materials and methods meet actual building codes [8-10], which will provide reliable experimental data.

2. The developed program of experimental studies will allow to determine the features of the stress-strain state for damaged reinforced concrete beams and their residual bearing capacity.

3. With the data to be obtained, it is planned to make proposals for calculation of the residual bearing capacity of inclined sections of damaged reinforced concrete beams of rectangular cross-section.

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