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O.V. Semko, Dr. of Sc., Prof.
O.P. Voskobiynyk, Dr. of Sc., Senior Scientist
I.O. Parhomenko, graduate student
P.O. Semko, master
Poltava National Technical Yuri Kondratyuk University

EXPERIMENTAL RESEARCH OF THE AMPLIFICATIONS METHODS OF CONCRETE FILLED STEEL TUBULAR ELEMENTS WITH EXPLOITATIVE DAMAGE

After analysis the several similar ways of amplification of tubular elements were proposed. The article presents results of experimental researches of different methods concrete filled steel tubular elements` amplification with local damage of pipe-shell. The most effective method of amplification which is the most improving for joint work of the sample was defined.

***Keywords**: Concrete filled steel tubes, damages, exploitation, behavior specifics.*

Statement of the problem in general and its relationship to important scientific and practical tasks. Application of concrete filled steel tubular constructions as bearing elements of composite reinforced concrete framework of industrial and civil buildings today is very relevant, especially with increased requirements for sanitary condition, and if necessary, the perception of significant operational loads [1, 2].

The presence of local damage of pipe-shell (local bends, cuts, cracks and other various of cross section) while operating can fairly significantly affect the features of work, bearing capacity and other indicators of roadworthiness of constructive elements that's why important the question of amplification of constructive elements. Currently [6, 7] this issue is not enough researched and needs the study.

The problem and set priorities for experimental research of concrete filled steel tubular elements with different ways of amplification was formulated in this work. The main **purpose of this work is** to analyze effectiveness of different ways of damaged tubular structures` amplification based on the experimental studies.

Analysis of recent research and publications on the topic of work. Theme of concrete and metal structures` amplification was reviewed in Malhanov A.I. [3] Onufriev N.M. [4] Bondarenko S.V.[5] and others. However, today in Ukraine almost no similar recommendations regarding reinforced concrete constructions.

The main material of research. The main advantage of concrete filled steel tubular designs - a joint work between the concrete and the pipe-shell. In consequence of which is effect of increasing of bearing capacity. Based on the results of previous studies [8, 9, 10] we found that the presence of defects or damage in constructive elements significantly reduces or almost reduce to zero before the end of unstudied effect of increasing of bearing capacity. Thus the main task of amplification of tubular elements is to restore joint work of all components of the design.

Different ways of amplification of tubular structures which have damage of pipe-shell were analyzed. After this analysis the several similar ways of amplification of tubular elements were proposed.

In order to establish the degree of influence of methods amplifying of bearing capacity, the changing nature of work under load and the parameters of the stress-strain state of tubular elements, us were made experimental researching. Their program included the manufacture and testing of short concrete filled steel tubular samples (with a ratio of l <4D), including a series ТБпп which consisted of 4 samples with different ways of amplification of pipe-shell:

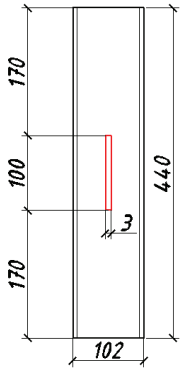
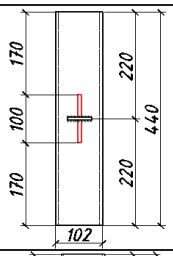
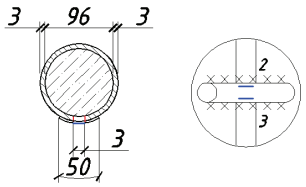
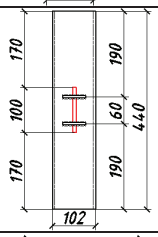
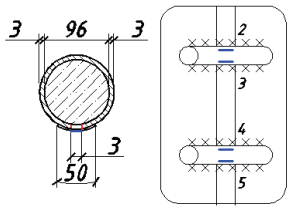
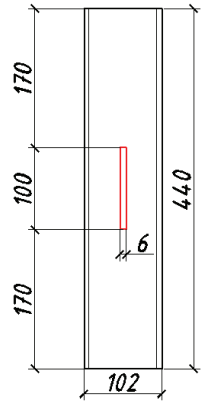
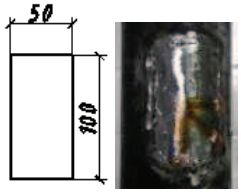
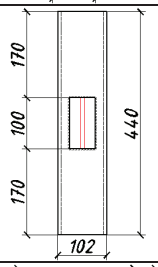
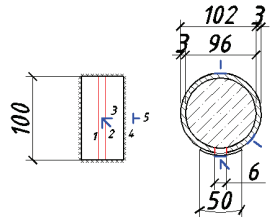
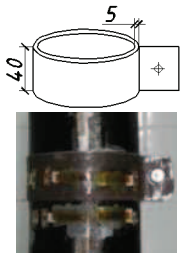
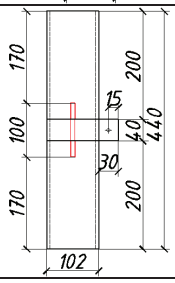
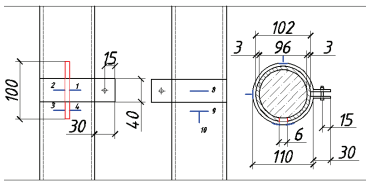
– using a reinforcing rod (1 pc), sample code ТБпп-1;

– using reinforcing rods (2 pcs), sample code ТБпп-4;

– using a metal plate (100x50mm) sample code ТБпп-2;
– using a metal collar, sample code ТБпп-3.

The adopted program and methodology of experimental research, physical and mechanical properties of materials, locations of strain gauges and methods of amplification are presented in Table 1.

Table 1 – Characteristics of test specimens

Sketch of samples	Method of amplification	Geometric characteristics of amplifications methods		Location of strain gauges
	a reinforcing rod Ø5 mm, length 50 mm	1 pc 		
		2 pcs 		
	the rectangular metal plate 100x50mm, t = 5 mm			
	collar t = 5 mm			

All samples were tested in central compression with centering for the physical and geometric center of the sample by applying a test load equal to about 0.2 from the expected maximum and comparison of longitudinal strain in a circle. During the test were recorded efforts which corresponding to the beginning of the yield strength of the metal pipe-shell (N_y) and load N_u. After reaching N_u sample ceased perceive the load which was taken as a criterion of destruction. However, the sample has not lost its integrity and continued to work in out the limiting condition, with significant plastic deformation at the bottom of the chart of physical condition.

When performing the experiment samples ТБпп-1 and ТБпп-4 had similar nature of destruction, i.e. disclosure of pre-existing damage and the formation of corrugations in the plots near actions of load. In the sample ТБпп-2 due the increasing of cross-sectional by plate corrugation have been formed on the opposite side of the defect and has occurred the loss of local stability. Since the sample ТБпп-3 was amplified, by all area of the cross section of the sample has occurred expansion without significant disclosure of the existing defect (Fig. 1).

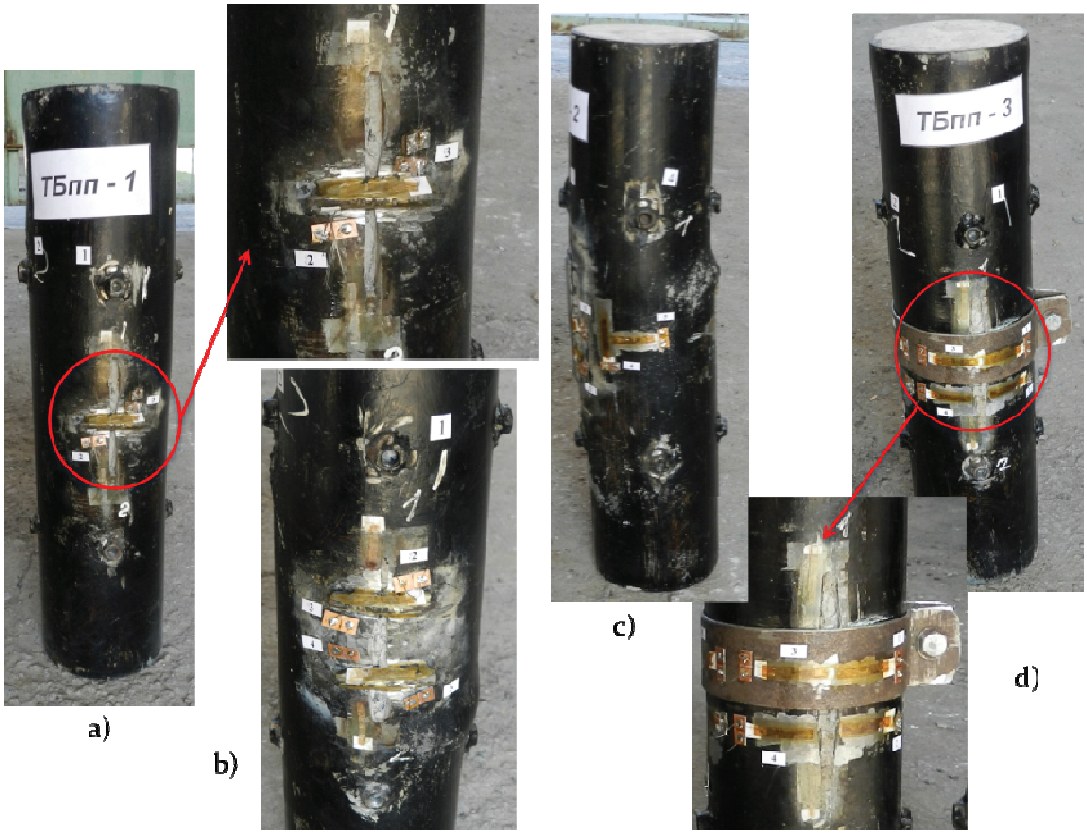


Figure 1 – The samples after test: а – ТБпп-1, б – ТБпп-4; в – ТБпп-3; г – ТБпп-2.

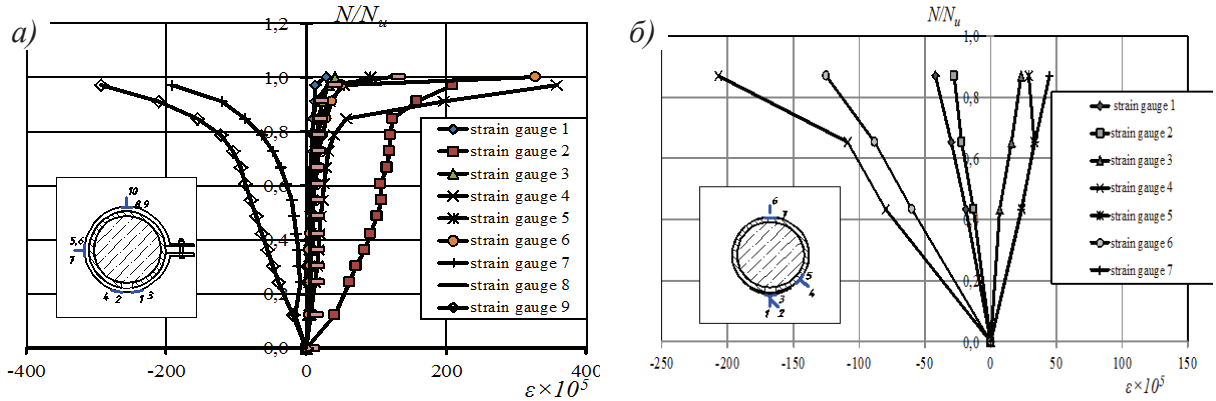


Figure 2 – Schedule of change longitudinal deformations of samples: a – ТБпп-3, b – ТБпп-2

These charts of the main deformation shows complex stress-strain state in the area of amplification (Fig. 2). For the sample ТБпп-3 clear that the method of amplification as a collar leads to increasing of joint work and the bearing capacity. In the sample ТБпп-2 which is amplified using a metal plates also increasing the bearing capacity of sample.

During the tests with the help of indicators the longitudinal deformations were derived $\varepsilon_{поздо}$ and circular charts of changes transverse deformations of test samples at different load levels was constructed (Fig. 3).

The formation of corrugations near actions of load is characteristic feature of the tubular structures' work. If corrugations are absent or occur immediately after the loss of local stability the effect of girdle is practically absent and amplification doesn't give the desired result in this case.

Thus, analysis of the results of executed experimental studies and calculations allow to conclude that the most effective way to amplification is a collar, it covers all sides of an item and does not give disclosed pre-existing damage.

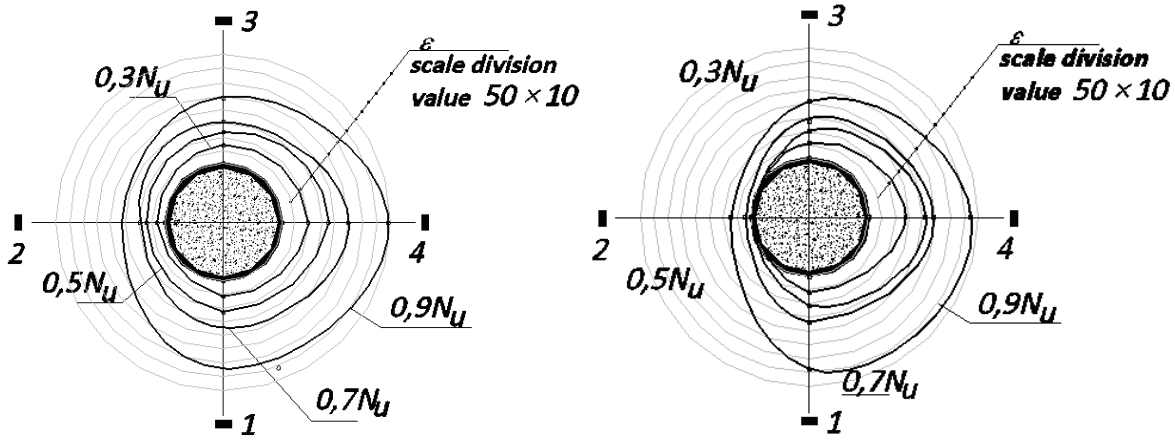


Figure 3 – Schedule of change of transverse deformations of test samples at different load levels: а – ТБпп-1, б – ТБпп-3.

Conclusions. The article presents results of experimental researches of different methods concrete filled steel tubular elements` amplification with local damage of pipe-shell. The most effective method of amplification which is the most improving for joint work of the sample was defined.

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О.В. Семко, д.т.н., професор
О.П. Воскобійник, д.т.н., с.н.с.
І.О. Пархоменко, аспірантка
П.О. Семко, магістр
Полтавський національний технічний університет імені Юрія Кондратюка

ЕКСПЕРИМЕНТАЛЬНІ ДОСЛІДЖЕННЯ СПОСОБІВ ПІДСИЛЕННЯ ТРУБОБЕТОННИХ КОНСТРУКЦІЙ З ЕКСПЛУАТАЦІЙНИМИ ПОШКОДЖЕННЯМИ

На основі проведеного аналізу авторами було запропоновано декілька способів підсилення для трубобетонних елементів, що уже мають пошкодження труби-оболонки. У статті наведені результати експериментальних досліджень різних способів підсилення трубобетонних елементів з локальними пошкодженнями труби-оболонки. Визначено найбільш ефективний спосіб підсилення, що включається в спільну роботу з дослідним зразком та збільшує ефект обойми.

Ключові слова: *трубобетон, пошкодження, експлуатація, особливості роботи.*

А.В. Семко, д.т.н., профессор
Е.П. Воскобойник, д.т.н., с.н.с.
И.О. Пархоменко, аспирантка
П.А. Семко, магистр
Полтавский национальный технический университет имени Юрия Кондратюка

ЭКСПЕРИМЕНТАЛЬНЫЕ ИССЛЕДОВАНИЯ СПОСОБОВ УСИЛЕНИЯ ТРУБОБЕТОННИХ КОНСТРУКЦИЙ С ЭКСПЛУАТАЦИОННЫМИ ПОВРЕЖДЕНИЯМИ

На основе проведенного анализа авторами было предложено несколько способов усиления для трубобетонних элементов, которые уже имеют повреждение труби-оболочки. В статье приведены результаты экспериментальных исследований разных способов усиления трубобетонних элементов с локальными повреждениями трубы-оболочки. Определен наиболее эффективный способ усиления, который включается в общую работу с исследуюмым образцом и увеличивает эффект обоймы.

Ключевые слова: *трубобетон, повреждения, эксплуатация, особенности работы.*

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