Вісник Тернопільського національного технічного університету
Scientific Journal of the Ternopil National Technical University
2017, № 4 (88)
*ISSN 2522-4433. Web: **visnyk.tntu.edu.ua***

UDC 621.177; 621.314

THE INFLUENCE OF THE RODS ANGULAR PROFILE HEIGHT ON RECTANGULAR WELDED TRUSS DEFORMATION

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Summary. *The paper is devoted to the study of deformation properties of five 18000 x 3600 mm welded rectangular trusses under the external static loads. Experimental specimens are made of the steel rolled angular profiles with different beam seat height. The scheme of loading specifying the operating mode of such a structure type has been chosen. Computer simulation experiment in ANSYS Workbench 14.5 software was performed. According to the results the values of deformation along the lower chord for each truss, maximum trusses deformations within the elastic properties of structural elements and dependence of bearing ability of the structure on its material consumption have been obtained . The results obtained are of theoretical and practical interest for both new trusses designing and testing of the bearing ability of trusses being in operation.*

Key words: *welded truss, truss deformation, truss bearing ability.*

Received 11.12.2017

Statement of the problem. Application of the welded trusses in the construction of modern industrial facilities is caused by the variety of their structure forms, high operation properties, technological effectiveness of their production and mounting. The design and production of welded trusses must meet the standard requirements of such a structure type according to the results of the SSS calculation parameters in their elements. Sufficient price growth of the steel rolled profiles the welded trusses are made of contributes to the thorough investigation of the deformation processes, damage and fracture of such structures in order to prevent the accidents resulted in standard operation loads, but in the overloadings as well, caused by different factors. These are the approaches which make possible to obtain the truss design possessing the required bearing ability values at their minimum material consumption, and then, their cost. Nowadays the level of development of computing machines and application of the numerical calculation methods make possible to solve this problem and estimate the structure bearing ability under different external factors taking advantage of the computing modeling experiment.

Analysis of the latest investigations and publications. Application of the finite-element analysis method implemented in different softwares for the calculations on strength makes it possible to choose the most efficient parameters of the structural elements while their designing, as well as the value and shape of its cross-section for the truss rods at the known general truss sizes and values of the influence factors on the structure.

While constructing the welded trusses the following must be taken into account [1…4]:

1) structure correspondence of the testing truss to the structure foundation basis;

2) mechanical properties of the material in whole and in the welded seam area resulted from its embrittlement;

3) softening of the seam area caused by the technological defects of welding (poor penetrations, slag inclusions);

4) residual stresses caused by the temperature deformations.

However, the available papers do not deal much enough with the optional approach to the application of different rod angular profiles.

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The Objective of the paper is to compare the deformation properties of the rectangular lower chord welded trusses of similar sizes and configurations, the difference being that rods are made of angle profiles of different sizes and wall thickness being equal.

Statement of the task. To obtain the challenged goal the investigation task has been stated, which deals with the identification of the deflection degree (lateral deformations) of the welded rectangular trusses with the rods of different angular profiles under static loadings.

To solve this problem it was necessary to perform the computer modeling experiment for five 18000 x 3600 mm lower chord rectangular welded trusses under the external discrete static loadings. It was solved methodically taking advantage of the numerical methods in the applied software complex ANSYS Workbench 14.5 environment, which is algorithmically based on the finite elements method. To model the behavior of the lower chord truss in the software complex ANSYS Workbench 14.5, its geometric and finite-element network model has been developed.

The results of investigations. The rectangular 18000 x 3600 mm truss with the three-angle lattice is being investigated. In Fig. 1 the configuration of the studied truss and the scheme of its loading are presented.

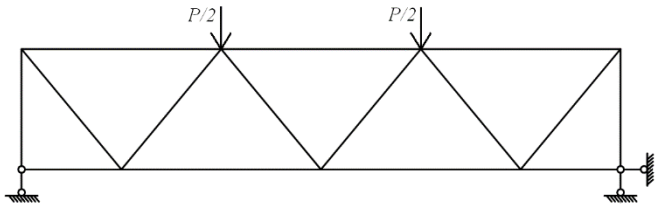

Figure 1. Configuration of a rectangular welded roof truss and its loading scheme

The truss consists of the upper and lower cords and the lattice. The lattice has the braces (sloping rods) and sticks (vertical rods), which connect the truss booms.

The loading mode is static. The scheme and the loading mode identify the operation conditions for the studied structure. The rods in the units are connected without flats. The truss is made of the general quality steel ВСт3пс. All welding seams are performed by the semi-automatic arc welding taking advantage of the DC 1.2 mm diameter Св-08Г2С wire electrode in the CO_2 medium following the standard technologies. The operation current of welding was 200 A.

The investigation of the welded truss deformation taking advantage of the computer modeling experiment method was carried out using the software complex ANSYS Workbench 14.5, which is algorithmically based on the finite elements method. The static analysis of the truss was performed. Here it is expected – that all loadings and the structure respond to the loading are constant or change in time very slowly.

The modeling was performed for five rectangular welded lower chord trusses made of rolled angle profiles of different beam seat heights (the number of the angle profile), but the thickness of these seats is equal (Table 1).

Table 1. Parameters of angular profile for the studied trusses elements

Truss number	1	2	3	4	5
Angle	80×80×10	90×90×10	100×100×10	120×120×10	140×140×10
Mass 1 m/kg	11,73	13,3	14,86	18,0	21,11
Truss mass, kg	801,16	908,4	1015	1229	1442

The vertical displacements along the lower chord of the truss under the static loadings of different discrete values, the structure can be subjected to, under the standard operation or

during the accidents (overloading), have been found. The obtained results are presented graphically (Fig. 2).

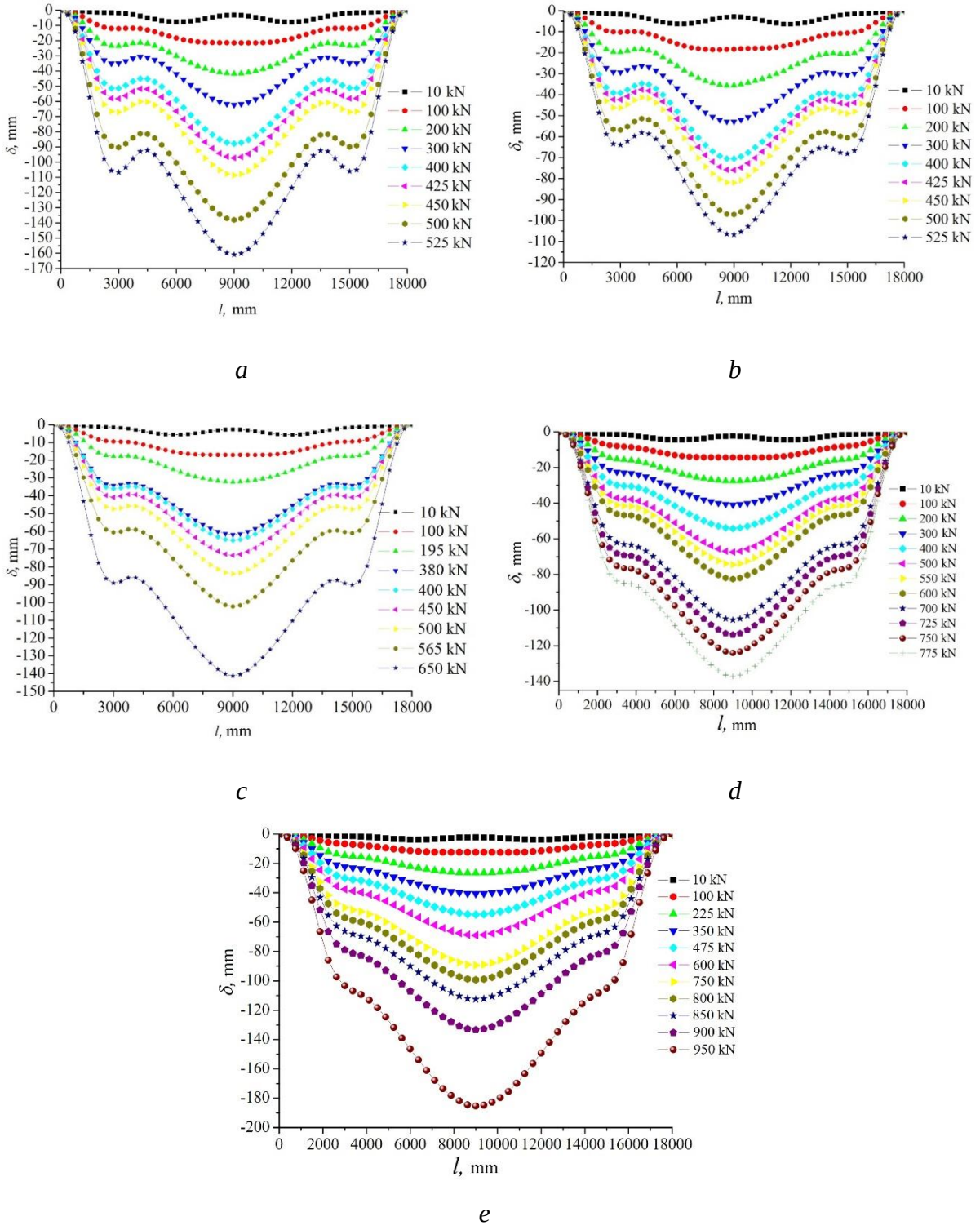

Figure 2. Deflections along the lower chords of 18000 × 3600 mm trusses made of different angular profiles: a – 80x80x10 mm; b – 90x90x10 mm; c – 100x100x10 mm; d – 120x120x10 mm; e – 140x140x10 mm

The vertical deformations on the middle segment of the structure for every of the studied trusses depending on the loading degree have been obtained (Table 2).

Table 2. Vertical deformations on middle segments of studied trusses

№	Loading *P,* kN	Lower chord deflection δ for the studied trusses				
		1	2	3	4	5
1	100	21,45	18,51	17,06	14,34	12,46
2	200	41,81	35,64	32,25	27,63	
3	300	62,17	52,86	45,43	40,92	
4	400	87,81	70,59	65,04	54,22	45,67
5	425	97,22	75,97	69,1		
6	450	108,59	81,95	73,49		
7	500	137,97	97,16	83,92	67,52	58,82
8	525	160,94	106,77	91,81		
9	600			115,45	82,62	68,98
10	650			141,30		
11	700				105,62	
12	750				124,11	89,42
13	775				137,28	94,22
14	800					99,32
15	900					133,44
16	925					192,22

According to the results of investigation, the deflection of every studied trusses along the vertical symmetry axis at different values of the external force influence has been obtained (Fig.3). It was found, that the plastic deformation for each of the studied trusses is being exhausted, when the structure deflection is $\delta = 90$ mm, which is C = 0,5% relatively to the length of the 18-meter truss.

The influence of the structure material consumption on the truss bearing ability within the plastic deformation of its elements has been investigated (Fig.4). The linear interpolation of the experimentally found points has been performed (rhombs in Fig.4) according to the least square method. Linear dependence between these data has been obtained.

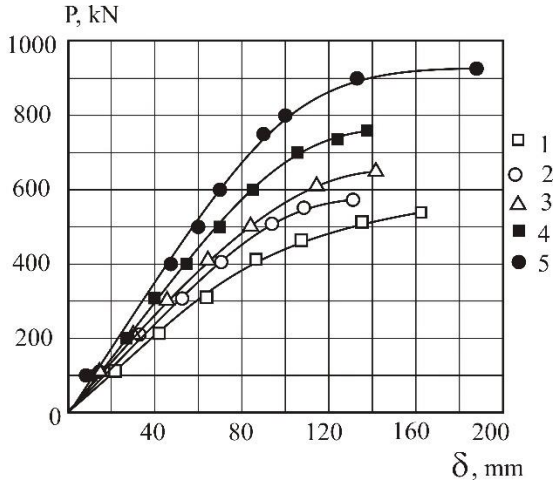

Figure 3. Deflections δ of studied trusses made of different angular profiles: 1 – 80x80x10 mm; 2 – 90x90x10 mm; 3 – 100x100x10 mm; 4 – 120x120x10 mm; 5 – 140x140x10 mm under external load *P*

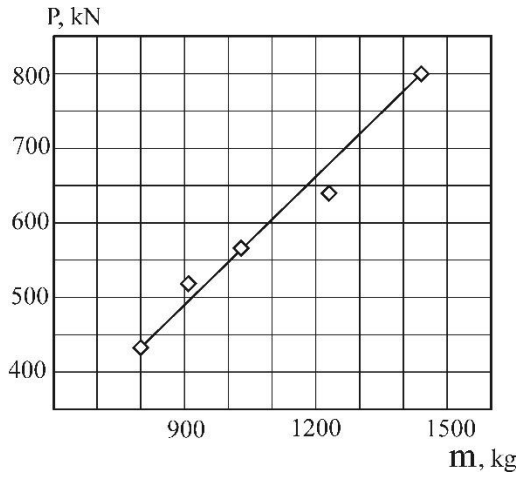

Figure 4. The influence of material composition of a construction on truss bearing ability within elastic deformation of elements

The obtained results are based on the method of computer modeling experiment applied in the previous investigations, in which the verification of the obtained results has been carried out and the great similarity with the nature experiments has been obtained [3, 4]. The parameters of the finite-element modeling have been chosen basing on this testified method, which provided high probability of the obtained results of modeling.

Conclusions. According to the results of the computer modeling experiment the deformation characteristics for the five 18000x3600 mm rectangular lower chord welded trusses made of rolled angle profiles of different beam seat height and its equal thickness, have been obtained. It was found, that the plastic properties of the structural elements material for all trusses are being exhausted, when the truss defection reaches $\delta = 90$ mm, which relatively to the 18-meter truss length is C = 0,5%. The influence of the structure material consumption on the truss bearing ability within its elements plastic deformation has been investigated. The linear dependence between these data has been obtained.

The results obtained in the paper are worth being applied for both design calculations of the welded trusses and for testing of the welded trusses bearing ability while their operation in order to prevent their accident damage.

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УДК 621.177; 621.314

ВПЛИВ ВИСОТИ КУТНИКОВОГО ПРОФІЛЮ СТЕРЖНІВ НА ДЕФОРМУВАННЯ ПРЯМОКУТНОЇ ЗВАРНОЇ ФЕРМИ

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Резюме. *Виконано дослідження деформівних властивостей п'яти зварних прямокутних ферм 18000 х 3600 мм при дії зовнішніх статичних навантажень. Дослідні зрази виготовлено зі стальних вальцьованих кутникових профілів з різною висотою полички. Вибрано схему навантажування, яка ідентифікує експлуатаційний режим для конструкції такого типу. За результатами виконання комп'ютерного моделюючого експерименту в середовищі ANSYS Workbench 14.5 отримано значення деформацій уздовж нижнього пояса для кожної з ферм, максимальні деформації ферм у межах пружних властивостей конструктивних елементів та залежність тримкості конструкції від її матеріаломісткості. Отримані результати становлять теоретичний і практичний інтерес як для проектування нових ферм, так і для перевірки тримкості ферм, які експлуатуються.*

Ключові слова: *зварна ферма, деформування ферм, тримкість ферм.*

Отримано 11.12.2017