RESTORATION OF THE FOUNDATION FOR THE NEW CHIMNEY STEEL SUPPORT STRUCTURE

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UDK: 69.059.32:697.8
DOI: 10.14415/konferencijaGFS2019.016

Abstract: *This paper covers the reconstruction of the chimney at the heating plant Visnjickabanja (municipality of Palilula, Belgrade) and restoration and reconstruction of the existing foundation of the chimney. The need for reconstruction emerged due to change of the raw material, i.e. the transition from fluid fuel (mazut) to natural gas. The existing chimney is self-contained, standing circular steel structure with external diameter of 1500mm, standing on the two-stepped foundation made of reinforced concrete. With the change of raw material there was the need for three separate chimney pipes, and because of that on demand of the investor, the project of supporting carrier with triangular cross section, with sides of length 3.0 m, was made. With the analysis of the existing foundation structure and based on the existing geotechnical elaborate, it was concluded that the foundation needs to be restored and repaired in terms of reinforcement and expansion.*

Keywords: *restoration, reconstruction, foundation reinforcement, chimney, spatial truss, steel structure, anchorages, geotechnical elaborate*

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1. INTRODUCTION

Due to the substitution of liquid fuel, mazut, with natural gas, in the Višnjičkabanja heating plant, it was necessary to replace the existing chimney with three new chimney pipes and to make the structure of a supporting carrier for the chimney. The design specification determined that new steel structure is supported with the existing foundation. However, a detailed analysis of the impact on the foundation and the way that the structure stands on it, it was concluded that it is necessary to perform its reconstruction and restoration.

2. CHIMNEY SUPPORT STRUCTURE
2.1. EXISTING CONDITION

Along with the existing boiler room there is a chimney with the height of 42 m. The chimney is a separate self-containedsteel structure, with an outside diameter of 1500 mm. The chimney structure stands on a reinforced concrete foundation. The connection of the existing chimney and the foundation is with 2x8 anchors diameter d=52 mm. At the anchor points, the web stiffeners of the lower chimney lining were made. With the reconstruction it is planned to remove the existing structure of the chimney and to install a new one on the existing reinforced concrete foundation.

Figure 1. Existing conditions

2.2. NEWLY DESIGNED SUPPORTING STRUCTURE FOR CHIMNEYS

The project envisages the construction of a steel structure of a pillar as a chimney carrier. The pillar is designed as a triangular cross section height H=34.30 m. Basically, the cross-section is a equilateral triangle with a side length of 3.0 m. The chords were made of round tubes and are interconnected by horizontals and diagonals, which are also made of round tubes. The cross section nodes are at a 3.0 m long axle spacing. The pillar structure consists of three assembly pieces interconnected with mounting attachments with front panels and high strenght bolts. The connection of the pillar and the foundation is accomplished by high strenght anchors attached with the half of the bonding force. Through the pillar, ladders with back protection that provide access to the revision platform were designed. The chimneys stand on the pillar through their supports connected to the pillar horizontals. Realized connections allow the transmission of both horizontal and vertical impacts on the pillar.

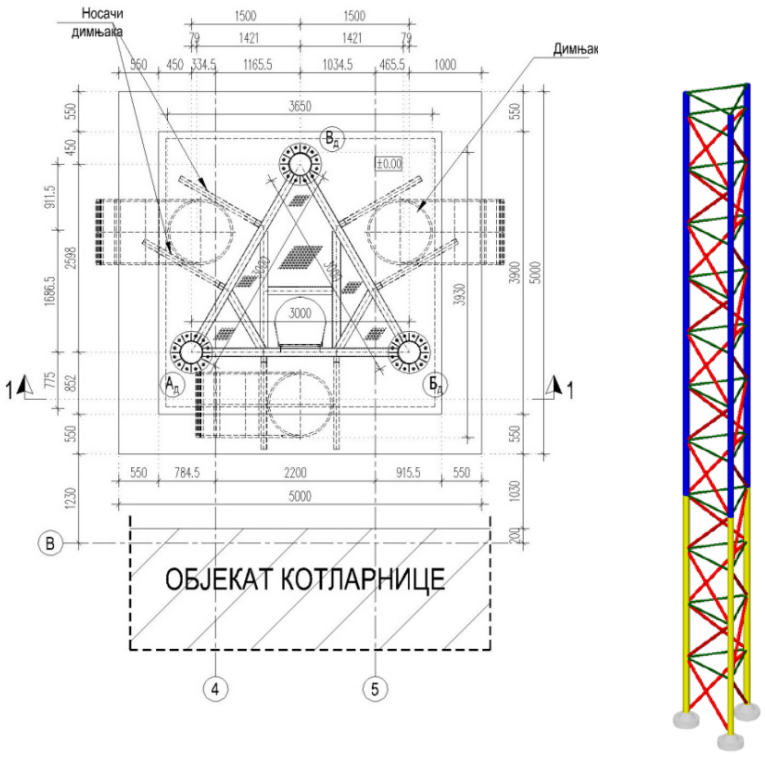

Figure 2. Newly designed supporting structure for chimneys

3. RESTORATION AND RECONSTRUCTION OF THE FOUNDATION
3.1. EXISTING CONDITION

The foundation is made of two steps, the lower step, with base dimensions of 5.0 x 5.0 m and 1.5 m in height and the upper step, with the dimensions of 3.7 x 3.7 m and 0.5 m inheight. This foundation structure was a support for a circular chimney, according to which anchors ϕ52 mm were placed over a radius of 3.0 m in diameter. By analysing the existing foundation structure, it was concluded that the newly designed chimney carrier required a reconstruction, that is, that the additional reinforcement and expansion of the existing foundation structure is necessary in order to achieve the projected connection of the pillar and the foundation and to ensure the stability of the whole structure.

Figure 3. Existing foundation

3.2. GEOTECHNICAL ELABORATE AND THE TESTING OF ANCHOR BOLTS

Based on the requirements of the Technical Control, a Geotechnical Elaborate was conducted. This elaborate contains: engineering geological reconnaissance of terrain, exploratory drilling and laboratory testing of soil samples. Based on the geological structure of the soil, soil replacement at a depth of 1.5 m below the foundation is prescribed, because due to time consolidation, the buffer layer became reconstituted. The existing buffer layer is necessary to expand from 6.0 x 6.0 m to a dimension of 7.4 x 7.4 m. The installation of the anchor for connection of the base of the lattice pillar was preceded by drilling holes of a certain depth, in which newly designed anchors would be installed. The determination of the load capacity of the anchors that were installed and sealed with epoxy was performed by introducing the tensile force and measuring the load capacity.

The three anchor bolts, which would connect the newly designed chimney carrier and the foundation, were tested in order to check their load capacity. The anchor bolts M30 quality 8.8 were tested on the projected force.

The tested anchor bolts were built in a concrete foundationat the length of 750 mm and sealed with epoxy-based mass. After 48 hours, the sealing mass obtained the required strength and the test was started.

Testing the anchor bolts with a test load implies its pulling with the tensile force Fnom=240 kN. The test load was applied gradually to the full load. Each subsequent loading phase was applied after the stabilization of the displacement due to the applied load in the previous stage. In the final stage at the nominal force in the anchor bolt, the force of the press was maintained until the complete stabilization, after which complete release was performed. The hydraulic kit, press, pump and digital manometer were used for testing. By analysing the obtained test results, it was concluded that the tested anchor bolts M30 with length of 750 mm can accept the required nominal force.

Figure 4. Testing of the anchor bolts

3.3. NEWLY DESIGNED FOUNDATION STRUCTURE

Reconstruction of the foundations envisages that its upper part is broken with retaining the existing reinforcement and anchors. After that, new anchors of the steel structure of the pillar are placed in the projected position. Anchors are placed in drilled holes 70 cm deep, in the lower part of the foundation and are sealed with epoxybased mass. After the installation of new anchors, the existing, old anchors are interconnected with the U140 steel profiles, the reinforcement is laid, and the upper part of the foundation is concreted. According to the new project, the upper part of the foundationhas been expanded and has the dimensionsof 3.9 x 3.9 m and the height of 0.5 m.
In order to stabilise the structure and reduce bearing stress in the ground, it is necessary to extend the bottom of the foundation. The expansion is carried out in the width of 70 cm by volume, so its new dimensions are 6.4 x 6.4 m, and the height is 1.5 m.

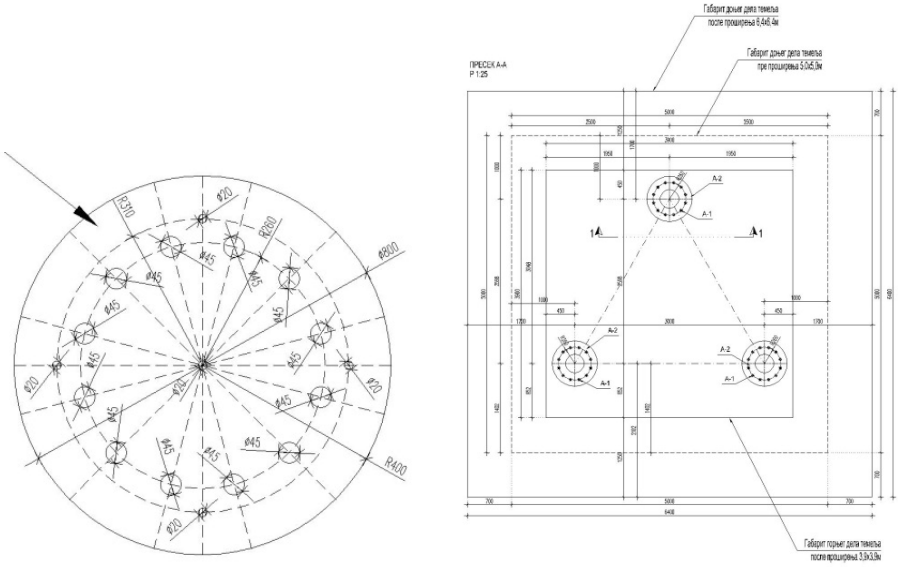

Figure 5. A template for the creation of new anchors in therestored foundation

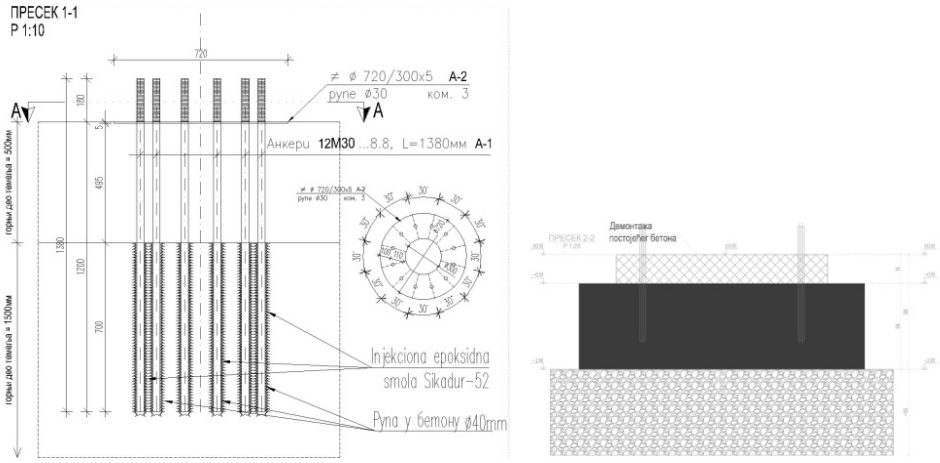

Figure 6. The layout of new anchors in the restored foundation

Figure 7. The restored foundation with new anchors

4. CONCLUSION

Newly designed structure required different support, i.e. different anchor arrangement and larger dimensions of the foundation. In order to adequately determine the state of the foundation and the soil below, it was necessary to dig it up to visually determine the state and do the geotechnical elaborate. It was kept in mind that the existing foundation should be used as much as possible. This was possible if its restoration was done, by increasing in dimensions and the installation of new anchors and reinforcement. It was also important to do the testing of the load capacity of the anchors and how to install them.
Such tasks should be performed with special care and caution, and all necessary measures should be taken to ensure and prove the stability and load capacity of the restored foundation structure, as well as soil in the immediate vicinity of the foundation.

LITERATURE

[1] Landović A.Bešević M.Tabaković D.," Change of use of the upporting structure of steel chimny", 14. International Scientific Conference : Planning, design, construction and renewal in the civil engineering-i NDIS, Novi Sad ,Srbija,21-23. novembar. 2018. pp.965-970. ISMN 978-86-6022-104-1.
[2] M.Bešević, A.Pančić, D.Kukaras "Repair design of short span reinforced concrete road bridge "ConfereceProcedings 4th International Conference Contemporary Achivements in Civil Engeneering Subotica; 2016, ISBN 978-86-80297-63-7,UDK 624.21:69.059.2. pp.31-39.
[3] Landović A,Bešević M, Prokić A, Đurić N. "Presentation of short span reinforced concrete bridges" International Conference CIBv (9; Brasov; 2017),Transilvania University publishing house from Brasov,2285-7656, vol,10, broj casopisa 1,str. 261-268.ISBN 2285-7656.
[4] Bešević M,Prokić A,Živković Smilja,Vojnić Purčar M,"Rehabilitation of roof structure of cylinder tank according to Eurocode" Savremena dostignuća u građevinarstvu (5; Subotica; 2017) ISSN:978-86-80297-68-2,Gradjevinski fakultet Subotica Univerziteta u Novom Sadu, str. 189-201.
[5] Bešević M,Landović A,Prokić A ,"Rehalibitation-underpinning of object due to removal (demolition) of ground floor columns", Savremena dostignuća u građevinarstvu (5; Subotica; 2017) ISSN:978-86-80297-68-2,Gradjevinski fakultet Subotica Univerziteta u Novom Sadu, str. 83-93.
[6] Bešević M., "Savremeni pristup sanacija nosećih betonskih konstrukcija", Zbornik radova Građevinskog fakulteta ISSN: 0352-6852, Vol.21, str.109-123.
[7] М.Бешевић, М.Гајић," Санација армирано бетонске конструкције пословног објекта у Црнотравској улици бр 2, Београд" СИМПОЗИЈУМ Врњачка бања 19-21,2012 –ДГКС,ДРУШТВО ГРАЂЕВИНСКИХ КОНСТРУКТЕРА Србије, стр.53-58.
[8] Бешевић М., Влајић.Љ," Санација адаптација и доградња објекта у Немањиној улици бр.9 уБеограду", ДГКС -13. КОНГРЕС, Златибор -Чигота, 2010-ЗБОРНИКРАДОВА,str. 445-452.

САНАЦИЈА ТЕМЕЉА ЗА ПРИХВАТАЊЕ НОВЕ ЧЕЛИЧНЕ КОНСТРУКЦИЈЕ ЗА НОШЕЊЕ ДИМЊАКА

Резиме: *Радом је обухваћена реконструкција димњака у топлани Вишњичка бања (општина Палилула, Београд) и санација и реконструкција постојећег темеља димњака. Потреба за реконструкцијом појавила се услед промене сировине тј. преласком са течниг горива (мазута) на природни гас. Постојећи димњак је засебна самостојећа кружна челична конструкција, спољашњег пречника 1500 mm и ослања се на армирано бетонски темељ који се састоји из два, степенаста дела. Променом сировине, појавила се потреба за три засебне димњачке цеви, па је на основу захтева Инвеститора, урађен пројекат носача димњака као просторне троугаоне решетке са страницама дужине 3.0 m. Анализом постојеће темељне конструкције и на основу израђеног геотехничког елабората, закључено је да је неопходно извршити његову санацију и реконструкцију, у смислу ојачавања и проширивања.*

Кључне речи: *санација, реконструкција, ојачање темеља, димњак, просторна решеткаста конструкција, анкери, геотехнички елаборат*