EXPERIENCE OF APPLICATION OF S355 J2 STEEL IN METAL STRUCTURES OF THE ROOFING OVER NSC «OLIMPIJSKY» (Kiev)

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Information on application of new high-strength S355 J2 steel at Ukrainian enterprises for welded metal structures of the roofing over NSC «Olimpijsky» in Kiev during its reconstruction is presented.

Keywords: *reconstruction, welded metal structures, high-strength steel, technology certification, mechanical properties, welding consumables, welding technology*

As part of preparation for the European Football Cup to be held in Ukraine and Poland in 2012, work is being actively performed on reconstruction of the existing and construction of the new sports facilities, as well as infrastructure in those cities (hotels, airports, bridges, etc.), where football matches will take place. One of the key objects in preparation for EURO-2012 for Ukraine is NSC «Olimpijsky» in Kiev, where it is planned to conduct in 2012 the final match of the championship. After reconstruction the main spots arena of Ukraine should meet the current requirements of UEFA and FIFA, which enable holding the European and world football forums. According to the project and plan of reconstruction (project author is GMP Generalplanungeselschaft mbH) already in 2011 a roofing protecting the spectators from bad weather will appear over the Kiev stadium (Figure 1). Being constructed by the principle of «ring and rope system» and consisting of two external compressed rings and inner stretched ring the roofing will cover the stands of the lower and upper tiers, as well as parts of the running track.

Compressed rings are lightweight hollow boxlike welded structures (Figure 2), which withstand the horizontal forces induced by 80 pairs of radial ropes connected to them. Individual elements of the ring are connected to each other by inclined column supports (Figure 3), which are box-like welded metal structures of variable section along the length and set of inner diaphragms to ensure their stiffness.

All the welded structures were made in Dnepropetrovsk «Zavod Master Profi Ukraina Ltd» from rolled sheets of S355 J2 steel, produced by local metallurgical works to EN 10025-1 2004. Steel with yield point above 350 MPa had the following chemical composition (analysis of certificate data), wt.%: 0.17 C; 0.2 Si; 1.44 Mn; 0.05 V; 0.04 Nb; 0.005V;

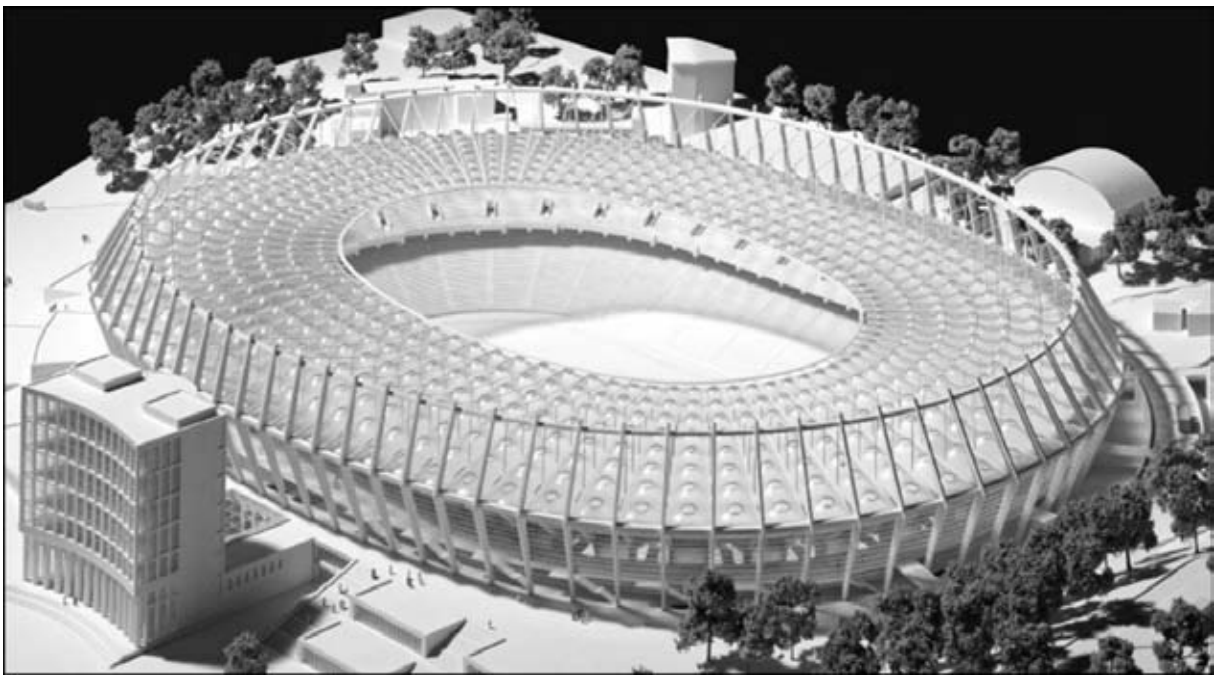

Figure 1. Design structure of the roofing over NSC «Olimpijsky» in Kiev

Figure 2. Compressed girth element in site

Figure 3. Appearance of columns ready for erection

0.005 S; 0.015 P. Rolled stock was made in Mariupol: up to 40 mm — at Illyich Metallurgical Works, and above 40 and up to 100 mm — at «Azovstal» Metallurgical Works.

Highly critical application of the roofing structure necessitated development of rational technologies of welding S355 J2 steel, providing equivalent welded joints with a high resistance to brittle and delayed fracture.

The short period of reconstruction predetermined the need to quickly take technology decisions on welding metal structures from S355 J2 steel. This was promoted by the stage of certification of welding procedures in keeping with DSTU 3951–2000, which preceded structure fabrication.

Proceeding from the developed in «Zavod Master Profi Ukraina» preliminary welding procedure specifications (pWPS), reference butt and tee joints of S355 J2 steel 16, 20 and 50 mm thick were made in the shop. Manual arc welding was performed with OK 53.70 electrodes (ESAB), mechanized welding in M21 mixture (Ar + 18 % CO_2) was conducted with Sv-08G2S solid wire of 1.6 mm diameter, and automatic submerged-arc welding with AN-47 flux was conducted with Sv-08GA wire of 4 mm diameter, using the newest automatic machines of ESAB and «Oerlikon Air Liquid 2143» specially purchased by the plant for fulfillment of this important order.

Proceeding from the obtained positive results of non-destructive and destructive testing of reference joints welding procedures were certified for all the types of welded joints of S355 J2 steel of 16–50 mm thickness, applied in fabrication of metal structures of the supporting frame of the roofing over the stadium.

Obtained from mechanical testing strength characteristics of welded joints (σ_t = 540–570 MPa) and impact toughness values (KCU_{-40} = 75–90 J/cm^2 and with sharp notch KCV_{-20} = 50–80 J/cm^2) meet project requirements made of welded joints in keeping with the local and foreign standards.

Work on metal structure fabrication was conducted from January to September of 2010, by the start of 2011 the last columns were mounted in the site of NSC «Olimpijsky», which was followed by the beginning of construction of the roofing proper.