RESISTANCE BUTT WELDING OF CONCRETE REINFORCEMENT IN CONSTRUCTION SITE*

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Considered are the issues of joining of concrete reinforcement bars in construction site using resistance butt welding (RBW). Pilot tests of developed technology for RBW of concrete reinforcement bars and equipment for its realizing were carried out directly in the construction site. It is shown that application of RBW in construction site provides for high economic effectiveness, rises construction efficiency and significantly reduces number of rejected joints. 7 Ref., 8 Figures.

Keywords: *concrete reinforcement bars, mobile complex for resistance butt welding, cast in-situ reinforced concrete, resistance butt welding*

Conditions of current construction of buildings from cast in-situ reinforced concrete require elongation of the reinforcement bars directly in construction site. This, first of all, is caused by application of reinforced concrete structures of more than 12 m (maximum length of reinforcement manufactured by metallurgical plants) and efficient use of metal stock. Different methods of welding of the reinforcement, mainly arc ones [1], are widely used in building and repair of reinforced concrete structures and constructions. Manual and semi-automatic arc welding as well as puddle-arc one found the widest distribution among these methods.

It should be noted that resistance butt welding (RBW) is widely used in addition to indicated methods at the plants and concerns, which manufacture precast reinforced structures. Today, this process is one of the leading methods for manufacture of reinforcement butt joints using technology of low-waste processing of bars under stationary conditions.

RBW process is characterized by high stable quality of welded joints and high efficiency. Application of RBW allows making full-strength joints, in comparison with base metal, that significantly increases safety and service life of reinforced concrete structures and provides for high efficiency. The welding process takes place in automatic mode, combining assembly and welding operations in one cycle, and requires no auxiliary consumables (electrodes, welding wire, fluxes, gases etc.) [2]. At that, welders' qualification has no special requirements.

Mechanical tests of the welded joints showed that they completely fulfil the requirements of DSTU 3760:2006 and GOST 10922–90 [3, 4]. A

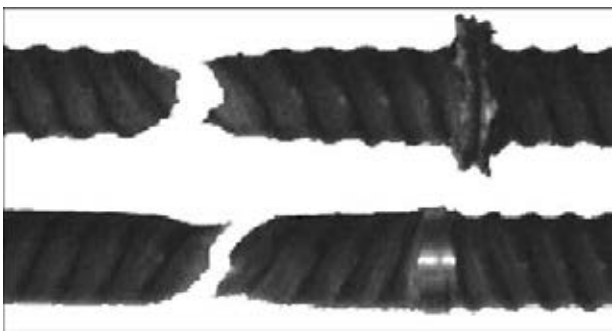

Figure 1. RBW joints of reinforcement after tensile testing

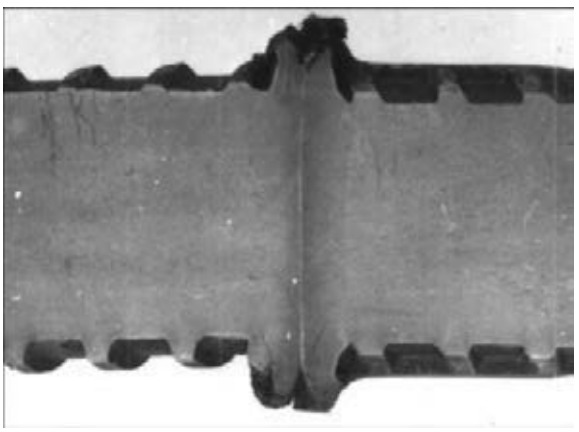

Figure 2. Macrosection of HAZ metal of RBW joint on reinforcement bar of A500 class

*Based on materials of work made in scope of program «Problems of life and safety of service of structures, constructions and machines». Kyiv: PWI, 2012, p. 468–472.

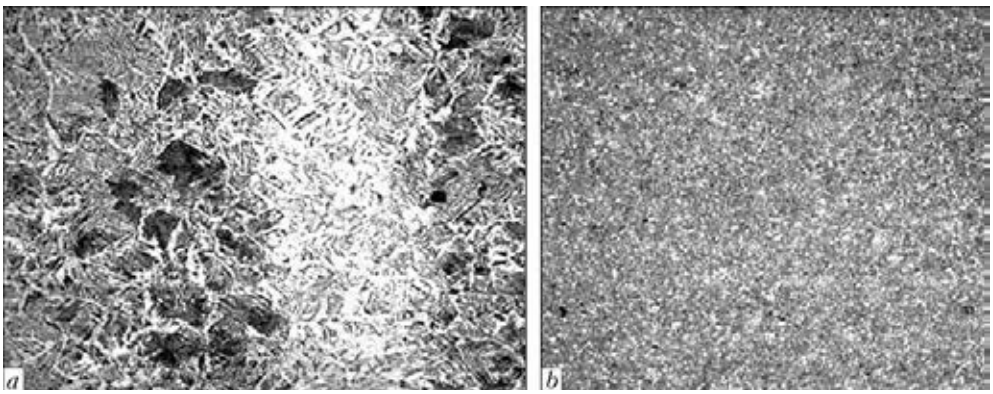

Figure 3. Microstructure (×100) of RBW joint on reinforcement bar of A500 class (*a*) and base metal (*b*)

failure takes place out of the welding zone in specimen tension (Figure 1).

Using of RBW of reinforcement provides for uniform heating of metal of zone of further deformation during upsetting (formation of welded joint). HAZ has small extension [5, 6].

Figure 2 shows a macrosection of HAZ metal reinforcement welded joint made using RBW, and Figure 3 depicts the microsections of RBW joint and base metal of the reinforcement.

Aim of this work lies in development of a line for RBW of reinforcement in construction site.

Present experience of development of technologies and special equipment for RBW of rails and pipes in field conditions allowed using this process for joining of concrete reinforcement bars under semi-stationary conditions directly in construction site. The E.O. Paton Electric Welding Institute developed the technologies of RBW of concrete reinforcement bars and pilot sample of mobile complex for realizing of these technologies directly in construction site. Modernized machine K813, earlier developed at the E.O. Paton Electric Welding Institute, was used in pilot samples of the complex. This development can be widely used in construction of commercial and residential buildings, bridges, trestleworks and other objects. Performed metallographic investigations

Figure 4. Structures of reinforcement cases of Podolsky bridge crossing over Dnieper River (*a*), bearers of VIP-sector of NSC «Olimpijsky» (*b*) and trestlework of terminal D of Borispol airport (*c*) (Kiev)

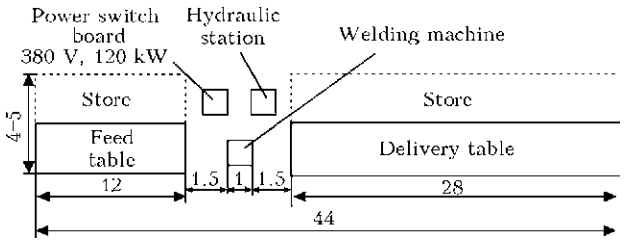

Figure 5. Scheme of line for welding of concrete reinforcement bars in construction site

Figure 6. Suspension RBW machine K813 adjusted for reinforcement joinig in construction site

and mechanical tests of reference industrial specimens showed that quality of the welded joints completely correspond to the requirements of acting reference documents [3, 4].

Requirements to special-purpose equipment are manly determined by the conditions of its operation. The equipment should be mobile, compact, have minimum possible electric capacity and maximum protection from environment. Application of mobile resistance butt machines during assembly is sufficiently difficult considering the complex structures of reinforcement cages of bridge crossings, trestleworks etc. (Figure 4). However, development of special mobile equipment for welding of reinforcement continues at present time.

A technological process for production of long reinforcement in construction site is developed in addition to the creation of such equipment. Prototypes of sites and lines for performance of indicated works were tested and manufactured. Figure 5 shows a scheme of typical line. Different variants of positioning of auxiliary equipment are

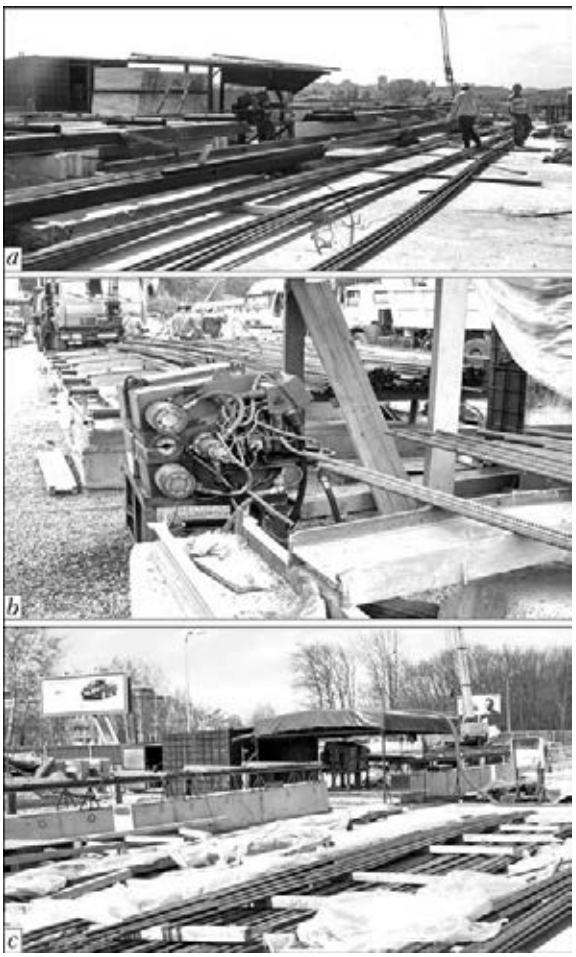

Figure 7. Prototypes of line for reinforcement welding in construction site (*a–c* — same as in Figure 4)

Figure 8. Objects and construction sites, where pilot tests of technology and prototypes of equipment were carried out (*a–c* — same as in Figure 4)

possible in the scheme depending on production conditions.

Since RBW methods received the widest distribution, all the experiments were carried out using modernized welding machine K813 (Figure 6) as base equipment.

The results of pilot tests of prototypes of reinforcement welding lines are shown in Figure 7.

Figure 8 shows the objects and construction sites, where pilot tests of technology and prototypes of equipment were carried out.

Conclusions

1. Quality of arc-welded joints on reinforcement bars depends, to significant extent, on welder qualification and conditions of storage of auxiliary consumables. Process efficiency is low, time of welding of one joint makes approximately 30 min.

2. RBW is carried out in automatic mode and requires application of no auxiliary welding consumables. At that, welders' qualification has no effect on quality of welded joints. Process efficiency is sufficiently high, time of welding of one joint does not exceed 1 min.

3. Application of RBW in construction site in the case of large number of welded joints (for example, hundred thousands to millions of welded joints are made at one bridge crossing) provides for high economic effectiveness, increases efficiency of construction and significantly reduces number of rejected joints.

4. Results of carried out pilot tests of the developed technology for RBW of concrete reinforcement bars and equipment for its realizing directly in construction site indicate the prospects of further development of given direction.

1. Brodsky, A.Ya. (1961) *Welding of reinforced concrete structures*. Moscow: Gosstrojizdat.
2. Kuchuk-Yatsenko, S.I. (1992) *Flash-butt welding*. Kiev: Naukova Dumka.
3. (2007) *DSTU 3760:2006*: Reinforcing bars for reinforced concrete structures. General specifications. Kyiv: Derzhspozhyvstandart.
4. (1990) *GOST 10922–90*: Reinforcing and embedded welded products, welded joints of reinforcing and embedded products of concrete structures. General specifications. Introd. 01.01.91. Moscow: Standart.
5. Chvertko, P.N. (2010) Flash-butt welding of reinforcement bars of A400S–A600S classes in construction of structures of monolithic reinforced concrete. *The Paton Welding J.*, **8**, 25–28.
6. Kugushin, A.A., Uzlov, I.G., Kalmykov, V.V. et al. (1986) *High-strength reinforcing steel*. Moscow: Metallurgiya.
7. Degtyaryov, I.A. (1965) *Welding in production and assembly of reinforcing structures*. Moscow: Energiya.

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