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TESTING OF THE SHOPPRIMER'S INFLUENCE ON THE QUALITY OF WELDED JOINT

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This paper presents the process of preparing the surface of construction material and applying the temporary protection that refers to the two-component epoxy workshop primer (shopprimer) in order to perform testing of its influence on mechanical properties of the weld. Testing of mechanical properties of welds after welding proved that there were no negative influences of the protective coating on the quality of welded joint.

Key words: welded joints, coating, non-destructive testing, mechanical properties, quality

INTRODUCTION

The necessity of greater control in the welding industry has increased along with the increasing level of automation and occurrence of new and advanced welding materials [1]. In addition to controlling of the welding process, it is also necessary to control the influence of protection systems on the properties of welded joints.

Materials are exposed to unfavorable environmental conditions, so there is a great danger of corrosion, which causes undesirable wear of material due to environmental influences. Corrosion can be characterized as a time-dependent process that causes a gradual reduction in wall thickness of material (e.g. of pipelines), indirectly causing significant consequences for society, environment and economy [2].

Since damaging occurrences and processes usually start on the material surface layer, it is necessary to undertake measures to protect that layer properly. Occurrence of corrosion impairs the surface quality, so before welding, the surface should be brought in an appropriate state. This requires additional financial costs. There are also cases when corrosion causes many damages, thus bringing overall functionality of the construction material in question. In order to avoid such situations, shopprimers are used as a means of temporary protection.

Shopprimers, as basic workshop coatings, protect materials. It is not necessary to remove them from the surface before welding. Shopprimers are applied in thin layers on stored steel materials, in order to reduce corrosive damage and to preserve materials for further application in the industry (e.g. in shipbuilding) [3].

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EXPERIMENTAL PART

This research focused on testing the influence of the two-component epoxy workshop primer (shopprimer) on the quality of welded joint. The influence was assessed by applying laboratory mechanical methods, being preceded by radiographic control. Tested specimens were made of the S235JRG material. After preparing of the surface, the material was treated by a protective coating. Chemical composition of the material is presented in the Table 1, and the Table 2 overviews mechanical properties of the base material.

Table 1 **Chemical composition of the material / mas. % [4]**

C	Si	P	S	N
0,17	+	0,05	0,05	≤0,007

Table 2 **Mechanical properties of the material [4]**

R_m / MPa	$R_{p0,2}$ / MPa	A_5 / %	Impact energy *KV* / J	
			min.	ϑ / °C
340 - 470	225	26	27	+20

Mechanical cleaning of the surface was done by abrasive jet to remove corrosion products from the surface and to make it rough, which was necessary for good binding of the protective coating to the material [5].

The effect of the jet in the mechanical process depends on various factors that need to be optimized, so that the quality of the treated area could be satisfactory. Hardness, shape and size of particles, as well as angle of incidence and jet velocity shall define the quality of treated surface [6].

Required quality of the surface after mechanical cleaning shall meet requirements of Sa 2½ according to the HRN EN ISO 12944/4 standard. Therefore, the surface roughness shall range from 40 - 70 µm. Six test plates were prepared and welded in three sets for testing of the mechanical properties. In order to secure the control specimen, two test plates were not treated with protective coating. The following two plates were treated with protective coating of 15 μm dry film thickness, as recommended by the manufacturer. The remaining two plates were treated with protective coating of 30 μm dry film thickness, referring to the value that is twice as high as the recommended thickness. The protective layer can be applied by airless spraying or by compressed air, with regular checking of the purity filter.

The control of the applied protective coating, i.e. the measuring of the dry film thickness, was performed by the Elcometer device. Such measuring is a non-destructive method, as the mentioned device operates on the principle of magnetism or eddy current, and the magnetic force between the permanent magnet and magnetic metal base is in inverse proportion to the distance between them [6].

After conditioning, the specimens were welded by Metal Active Gas welding by arc wire with protection of CO_2 active gas. The main welding parameters applied in the experimental part are listed in the Table 3.

In Metal Active Gas welding, the electric arc is established by short circuit between the fusible, continuous electrode in form of a wire and the workpiece, i.e. by connection to the poles of direct current [7].

Table 3 **Parameters of Metal Active Gas welding**

Procedure	135
Position of welding	PA, PB, PF
Filler material	EN ISO 14341A: G 3 Si 1
	EZ-SG2
Diameter / mm	2
Current / A	130 - 280
Voltage / V	21 - 26
Welding speed / cm/min	18 - 40

After welding of specimens, welded joints were subjected to radiographic control, which requirements have to be met before testing of mechanical properties, in line with the standard EN ISO 17636-1, with the B sensitivity class. Interpretation of irregularities was carried out in accordance with the standard EN ISO 6520-1. Radiographic control proved that all three sets of specimens met the determined requirements. In order to determine if there was a negative influence of the protective coating on the quality of the welded joint, there were three tests performed on mechanical properties of welded joints, as follows:

1) Testing of macrography
2) Testing by bending
3) Testing of impact energy

There were 8 testing tubes prepared from each of the welded sets, of which 3 tubes were used to test toughness (Charpy V), 2 tubes were used for testing by bending, and 3 tubes for testing of structural properties.

Testing of structural properties, i.e. macrography of material, is performed under magnification from 5 to 20 times to detect cavities, gas bubbles, non-metallic particles, etc. Test tubes containing specimen without applied protective coating were used as a reference, as shown in Figure 1. Performed tests on the treated specimens, as shown in Figures 2 and 3, proved that there were no impurities or errors on the specimens and that the macrostructure of treated specimens was equal to the structure of reference specimen.

The testing by bending, i.e. testing of bending strength was conducted by the three point bend test. Tough material, like steel, is subjected to this test in order to determine the stress level at which permanent deformation shall occur, i.e. in order to determine the ability of deformation of the tested material [8].

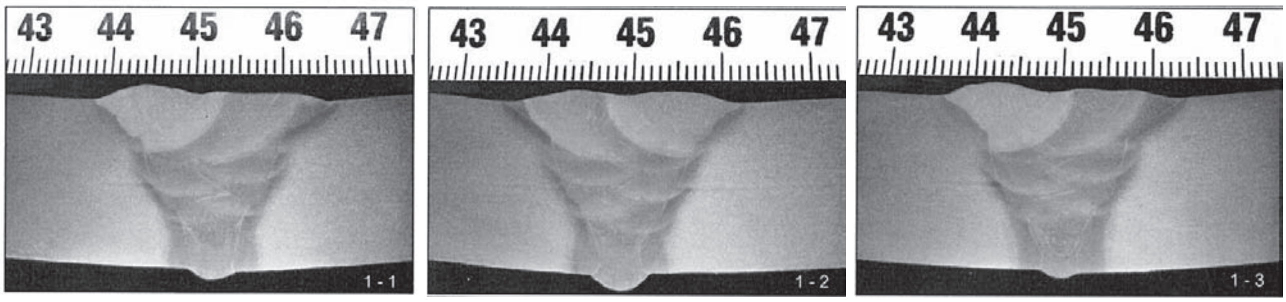

Figure 1 Macrography of reference specimens

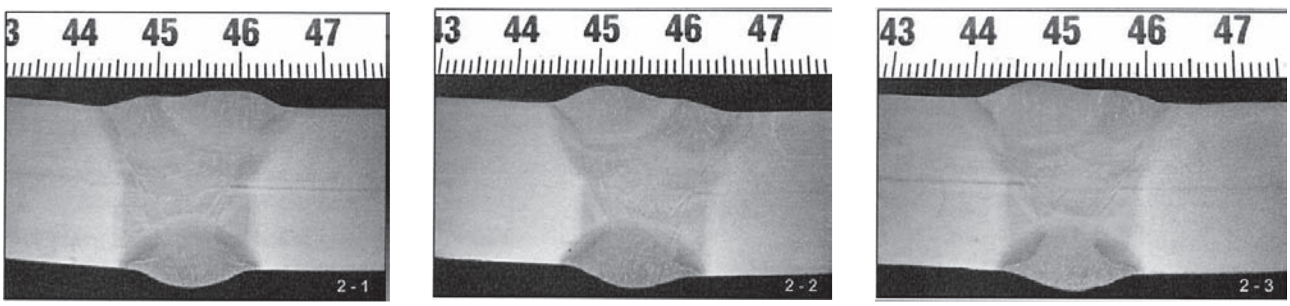

Figure 2 Macrography of specimens treated by protective coating in the recommended dry film thickness

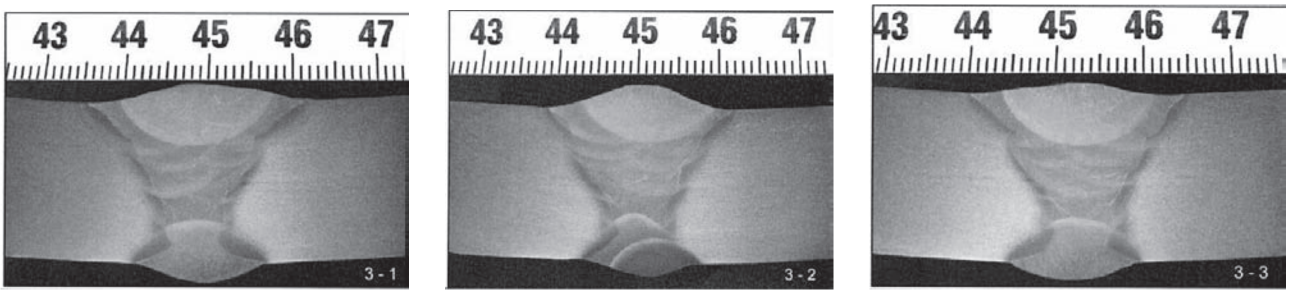

Figure 3 Macrography) of specimens treated by protective coating in the twice as high dry film thickness as recommended

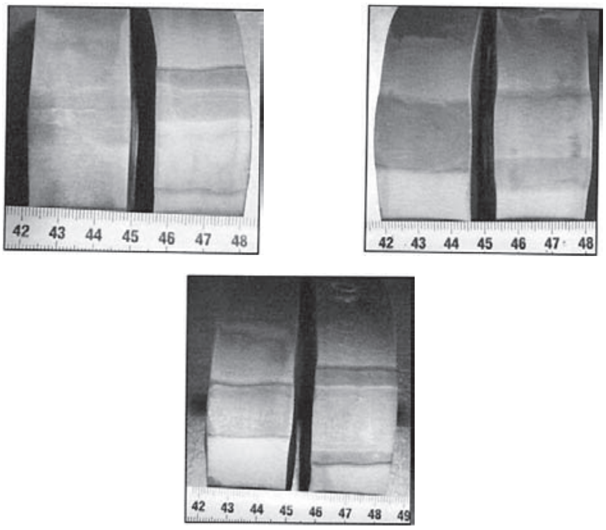

Figure 4 Specimens after bending of the weld face and root

The bend test confirmed no negative influence of shopprimer on stress value, i.e. on the deformation of specimens. As seen in Figure 4, face and root of welds subjected to the three point bend test were of the same quality. Since the surfaces of specimen treated with the protective coating were the same as the surface of reference specimen, it was concluded that the protective coating did not have a negative influence.

Testing of impact energy was performed by the Charpy method in order to test resistance to brittle fracture. Characteristics of the method are defined by parameters, such as the piston stroke from 5 to 5,5 m/s, and specimen with U or V notch (in this case V notch was used). Energy used to break the specimen indicated the material toughness value [8].

Table 4 **Values of impact energy of reference specimens**

Temperature / °C	Impact energy / J			Σn/n / J
	1-1	1-2	1-3	
20	130	120	135	128,3

Table 5 **Values of impact energy of specimens treated by protective coating in the recommended dry film thickness**

Temperature / °C	Impact energy / J			Σn/n / J
	2-1	2-2	2-3	
20	165	135	150	150

Table 6 **Values of impact energy of specimens treated by protective coating in the twice as high dry film thickness as recommended**

Temperature / °C	Impact energy / J			Σn/n / J
	3-1	3-2	3-3	
20	130	125	145	133,3

Testing of impact energy showed that the values of energy used to break the specimens were satisfactory in all three cases, being greater than the required limiting value for the tested material, which was 27 J. Deviations from the mean values of the impact energy for reference specimens, as shown in Table 4, and for specimens treated with protective coating of shopprimer, as shown in Tables 5 and 6, were not great, so it can be concluded that the protective coating did not have a negative influence on the welded joint, i.e. it did not affect negative change of mechanical properties.

CONCLUSION

Testing of structural properties indicated that in the welding zone, there were neither visible defects nor deviations in macrographic photos between specimens treated with protective coating and the reference specimens. Results of the bend test were evaluated as good, meaning that no visible mechanical damage occurred either on the weld face or on the weld root after subjecting them to bending. Testing of the impact energy proved that the protective coating did not have negative influence on the values of impact energy, i.e. the measured values were not below the permitted value, nor there was a significant deviation in the mean values between the two tested specimens with protective coating and the reference specimen. According to the obtained results, it was proved that there was no negative influence of protective coating combustion and its mixing with the gas used in welding. Therefore, it is concluded that it was safe to use the shopprimer as a temporary protection of materials.

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