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Experimental Measurements of Adherence of Thermally Sprayed Layers

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The bond strength of the thermally sprayed coatings is one of the most important features in the assessment of deposition quality. Standardized methods for determining the adhesion of thermally sprayed coatings refer to the layers deposited on flat surfaces and on the outer diameter of the cylindrical parts. Thermal spray deposition on internal cylindrical surfaces is particularly difficult for low diameter. In the case of inner cylindrical surfaces, one of the parameters that strongly influence adhesion is the diameter of the parts on which the deposit is made. The proposed method of measuring the adhesion of thermally sprayed layers offers concrete values of shear breaking force. This method can be successfully used especially for experimental samples having a small internal diameter.

Keywords: *thermal spraying, bond strength, deposited layers*

1. Introduction.

One of the most important qualitative factors of the layers deposited by thermal spraying is the adhesion of the layers to the substrate. Adhesion can be quantitatively evaluated as representing the unitary effort of detaching layers deposited by thermal spraying against the substrate. The main demand for the layers deposited by thermal spraying on the inside of the cylindrical surfaces during operation is the shearing. Given the boundary conditions for depositing these layers relative to the deposition conditions on the outer cylindrical surfaces, it can be argued that methods of determining adhesion which refer only to the layers deposited on the outer cylindrical surfaces are not conclusive. [2, 3, 4, 5]

2. Realization of experimental samples.

Experimental samples were used for thermal arc spraying, and brass and bronze wires were used as the addition materials (Table 1). The technological parameters used for depositing the layers are inserted in Table 2. The substrate for these samples is OLT35 steel.

Table 1. Supplement materials used for experimental samples

Marking of specimens	Type of material	Chemical composition, [%]
P1	Metco Copper	Cu – 99,8
P2	Sprabronze AA + Laromet	Cu – 90, Al – 9, Fe – 1 + Cu – 63, Zn – 37
P3	Laromet	Cu – 63, Zn – 37
P4	Sprabronze AA	Cu – 90, Al – 9, Fe – 1

Table 2. The technological parameters for electrical arc spraying

Marking of samples	Rotations, [rot/min]	Arc amperage, [A]	Arc voltage, [V]	Compressed – air pressure, [bar]	Spraying distance, [mm]	Bevel of spray gun, [°]	Layer temperature, [°C]
P1	200	200	26-30	2.4	110-130	Max. 45	80-100
P2	200	200	28-32	2.4	130-150	Max. 45	80-100
P3	200	200	35-36	2.4	130-150	Max. 45	80-100
P4	200	200	28-32	2.4	130-150	Max. 45	80-100

From the point of view of preparing the surfaces for depositing the layers, the following steps were taken: internal turning, threading, sanding.

The final appearance of the samples is shown in Figure 1.

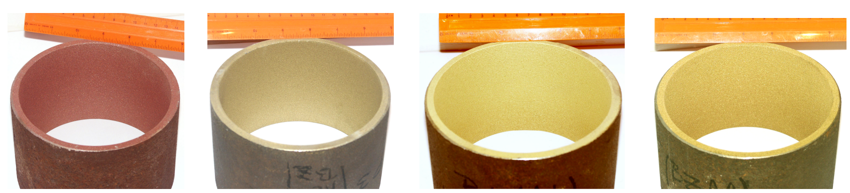

Figure 1. The final appearances of the samples P1 – P4

3. Description of the method of determining adhesion.

From these pieces were cut 10 mm wide rings. Subsequently, bushings having an outer diameter smaller than 0.5 mm than the inside diameter of the rings were machined. These two pieces were glued together with a special adhesive. The four ring bushings were tested on the universal traction machine, the forces with which the breaks were produced were: P1 – 5,82 [tf], P2 – 4 [tf], P3 – 4,5 [tf], P4 – 3,5 [tf].

The look of the samples after breaking is shown in Figure 2.

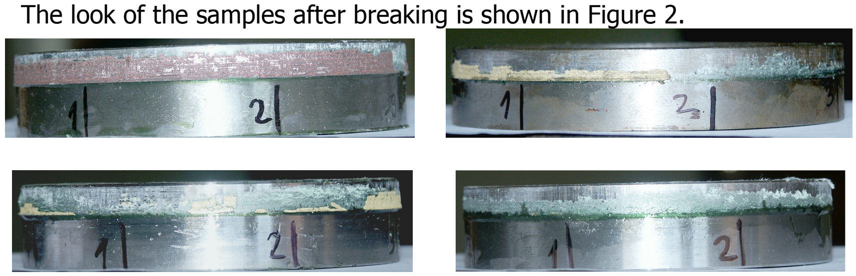

Figure 2. The appearance of the specimens after the breakdown testing

The calculation of the unitary shear effort involves determining the surface of the layer that has stuck to the bush. Thus, the surfaces of the four bushings were scanned, the resulting images being then processed.

These final images were then processed using a software that allowed their grids and quantification of the broken surface. A suggestive picture of this operation is shown in Figure 3.

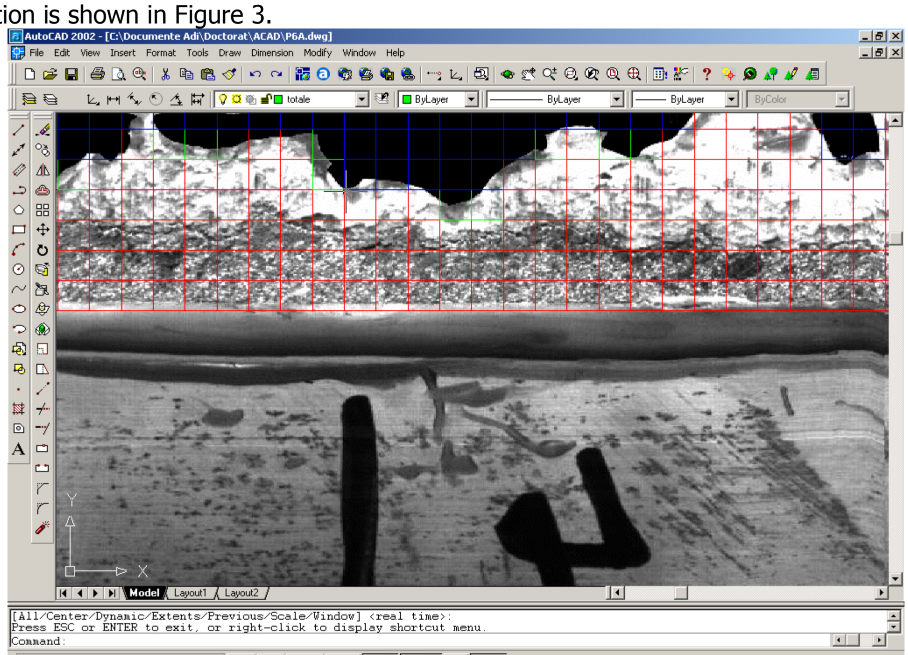

Figure 3. Aspect of processing the scanned image

The unitary shear effort was calculated by reporting the breaking force at the bonded surface. The results obtained are found in Table 3.

Table 3. The experimental results

Marking of specimens	Force, [N]	Diameter, [mm]	Sticking area, [%]	Shearing stress, [N/mm^2]
P1	51.777,2996	137,2	80	15,01
P2	35.585,77292	137,6	38	21,66
P3	40.033,99454	137,6	78	11,87
P4	31.137,55131	137,6	62	11,62

4. Conclusion.

This method makes it possible to calculate the unitary shear stress of the layers deposited by thermal spraying on the inner diameters of the parts. Also by this method qualitative appreciation of adherence can be made.

Since the rupture does not occur entirely at the layer level, it can be concluded that the calculated values are the minimum values at which the shear occurred.

References

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