Qualitative and quantitative comparisons on reconditioning by welding of crankshafts from auto industry

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Qualitative and quantitative comparisons on reconditioning by welding of crankshafts from auto industry

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Abstract. One of the goals of modern society is represented by reducing the cost for the maintenance of cars. One of the pieces that break down most often on the engine block is the crankshaft, in various areas of it. Due to the fact that the price of a crankshaft is very high, specialists seek solutions for repairing and not replacing them. In this study, it is presented a comparison in terms of hardness obtained at recovering the counterweight by welding by using two methods of welding, WIG and SMAW through various techniques: normal, WTO, lateral depositing.

1. Introduction

The present work aims to offer solutions for repairing by welding in a situation in which the non-compliance occurs, which may endanger the safety of operation, on the counterweight on the crankshaft from automotive industry, shown in figure 1.

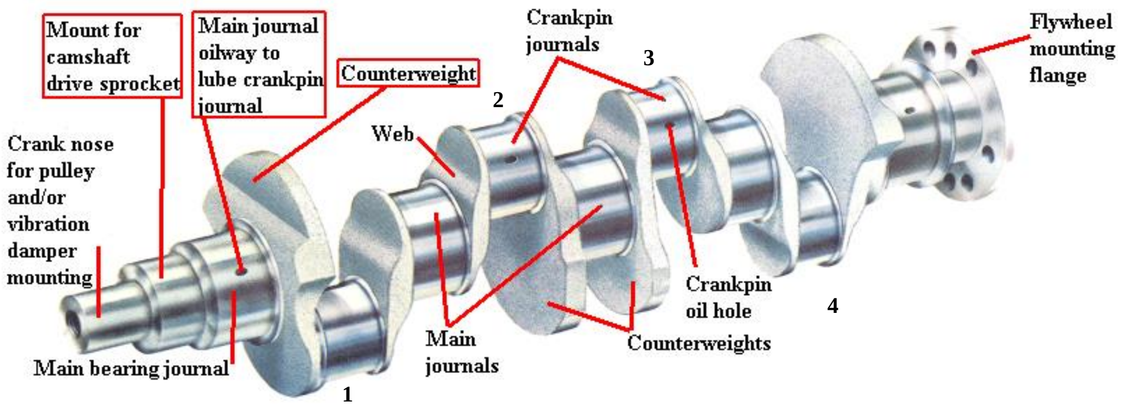


Figure 1. The components of a crankshaft [1]

For rebuilding the geometric dimensions, the favorite repair processes of crankshaft are welding and metallization.

The metallization process presents as main disadvantages, the high cost and the thorough preparation of the piece.

The main problem when applying the technology of repairing by welding is represented by the overheating of the support material which leads to irreversible mechanical and structural transformations.

In order to perform the experiments we opted for 2 repairing techniques, Weld Toe Tempering Technique and depositing lateral layers on counterweight components on a crankshaft from automotive industry, where we used 2 welding processes with electric arc SMAW and WIG.

Weld Toe Tempering Technique involves depositing a layer or an additional passage (supplementary) at the surface of the cord to ensure the recovery effect of the interlayer HAZ deposited above [2,3]. The technique seeks mainly to improve resilience of heat affected zone (HAZ/ZIT) by reducing its enlargement. The additional layer deposited must not form a liquid metal bath with the base material [4].

The depositing technique of lateral layers (left-right), aims to achieve similar effects on the ZIT as and in the previous case, but with a higher consumption of added material by depositing and subsequent removal of the layers [5].

Both techniques seek to improve the structure and hardness of the heat affected zone that appears when using welding processes [6].

2. Experimental data

The basic material from which the counterweight was made is a cast iron, type EN-GJS-600-3 according to DIN EN 1564: 2012.

Regarding the purpose of applying the techniques of reconditioning exposed above the surface of the counterweight, a channel has been made with all the dimensions of 16 mm width and depth of 5 mm, figure 2, which simulates the removal of an area with nonconformities, which will be subject to repairing by welding. Realizing the channel took place through mechanical processing with continuous cooling in order not to influence the thermal structure of the material.

Figure 2. The achieved channel.

The parameters used in the experiments are indicated in table 1.

Table 1. The parameters used in the experiments.

No. crt.	Parameter		Process	
			SMAW	WIG
1.	Filler material		E10-UM-60-CZ	WSG-3GZ-5-T
2.	Filler material diameter [mm]		3.25	2.4
3.	The intensity of welding [A]	Layers	140	
		Additional Layer Depositing	100	
		Lateral Layers Depositing	100	
4.	ARC voltage [V]	Depositing Layers	22	14
		Additional Layer Depositing	24	16
		Lateral Layers Depositing	22	14

3. Results and discussions

The encoding of samples was: P1- the resulting normal deposit sample using the SMAW procedure; P2 – the resulting sample in Weld Toe Tempering Technique using the SMAW procedure; P3 – the sample resulted by depositing lateral layers using the SMAW procedure; P1'- the resulted sample by normal depositing using the WIG procedure; P2'- the resulted sample through the Weld Toe Tempering Technique using the WIG procedure; P3'- the resulted sample by depositing lateral layers using the WIG procedure;

After completing the experiments, the test results, figure 3, were subjected to examination of optical-visual and penetrant liquids, not finding any non-conformity.

a) The usual technical depositing – SMAW sample P1

b) Weld Toe Tempering Technique – SMAW sample P2

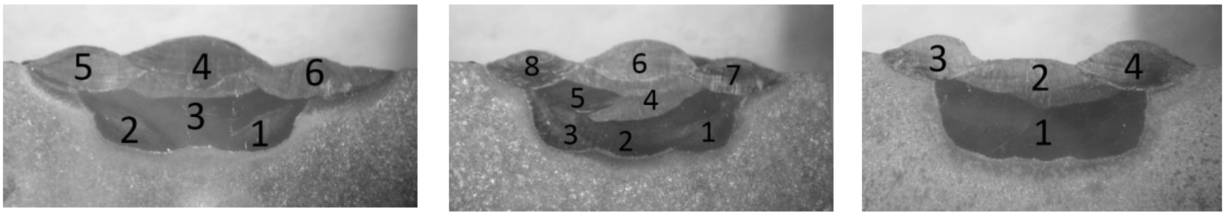
c) Depositing lateral layers - SMAW sample P3

d) Weld Toe Tempering Technique – WIG sample P2'

e) Weld Toe Tempering Technique – WIG sample P2'

f) Depositing lateral layers WIG sample P3'

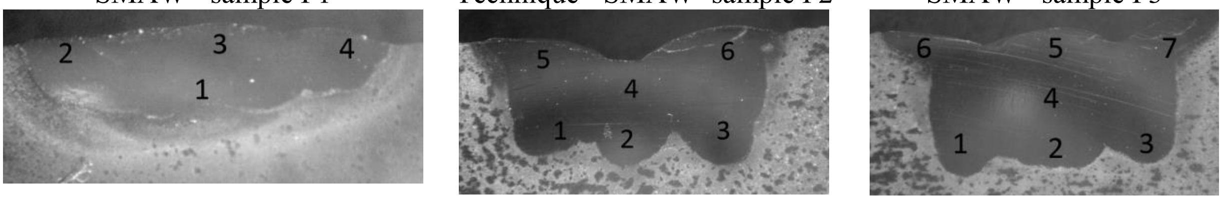
Figure 3. Image of resulting samples.



a) The usual technical-depositing SMAW - sample P1

b) Weld Toe Tempering Technique - SMAW- sample P2

c) Depositing lateral layers – SMAW - sample P3



d) The usual technical-depositing - WIG - sample P1'

e) Weld Toe Tempering Technique - WIG - sample P2'

f) Depositing lateral layers WIG - sample P3'

Figure 4. Samples for microscopic examination and measurement of hardness resulted after appropriate processing.

The reconditioned welding counterweights have been debited in the central area to obtain samples that were subjected to macroscopic examination and measurement of hardness. The samples after processing are shown in figure 4, in which it is indicated with numbers, the order of the layers in the channel provided for in the counterweight, as follows: 1 - the first layer, 2 - the second layer and so on.

After the macroscopic examination we took the hardness values HV0.5, in the areas shown in the figure 5. The values obtained are shown in table 2 and the charts, some of the areas analyzed, showing the variation of hardness can be found in figure 6-8.

Table 2. Hardness Values HV0.5 – all samples.

Area	Localization	No. Points.	Samples - SMAW			Samples - WIG		
			P1	P2	P3	P1'	P2'	P3'
S1	ZIT 1	1	689	496	723	434	700	584
		2	653	524	726	439	620	581
		3	677	508	737	460	618	590
		4	647	494	760	498	600	588
		5	611	562	728	495	655	515
	ZIT 2	6	535	414	466	311	333	324
		7	527	374	402	317	338	333
		8	437	376	382	315	356	326
		9	420	365	375	316	341	331
		10	409	382	392	321	343	331
S2	ZIT 1	11	632	471	752	337	762	521
		12	665	561	762	314	776	578
		13	687	527	740	340	718	505
		14	644	591	710	337	728	589
		15	615	524	751	373	770	526
	ZIT 2	16	520	337	387	335	376	345
		17	470	340	353	347	393	360
		18	399	312	351	342	372	355
		19	347	327	334	321	382	335
		20	374	356	367	320	351	337
Superior Cords	Cord 1	21	261	618	431	291	380	370
		22	273	610	427	260	386	359
		23	240	584	370	250	367	358
		24	250	598	466	262	372	357
		25	275	616	434	248	364	336
	Cord 2	26	251	505	253	253	299	269
		27	233	491	259	207	301	281
		28	238	508	248	235	290	273
		29	245	474	255	206	297	283
		30	238	500	250	215	308	271
	Cord 3	31	259	457	324	240	461	353
		32	280	501	386	232	493	376
		33	268	492	358	271	439	355
		34	278	556	385	261	519	346
		35	261	546	366	240	501	362
Bottom Part	Bottom Cord	36	331	337	327	369	406	398
		37	348	368	314	351	420	410
		38	329	355	328	364	399	380
		39	347	350	315	358	400	383
		40	341	376	316	357	391	367
	ZIT	41	508	330	441	427	352	414
		42	428	333	402	420	358	372
		43	503	392	426	431	363	373
		44	492	354	412	447	329	366
		45	415	325	391	423	340	374

After the macroscopic examination we took the hardness values HV0.5, in the areas shown in the figure 5. The values obtained are shown in table 2 and the charts, some of the areas analyzed, showing the variation of hardness can be found in figures 6-8.

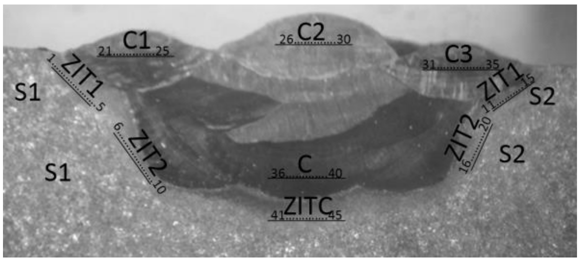


Figure 5. Hardness measurement areas.

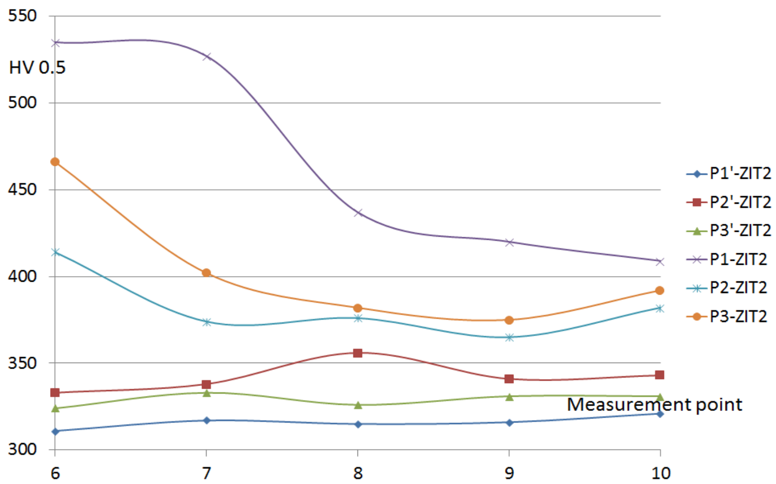


Figure 6. Variation of hardness – S1 - ZIT2 Area.

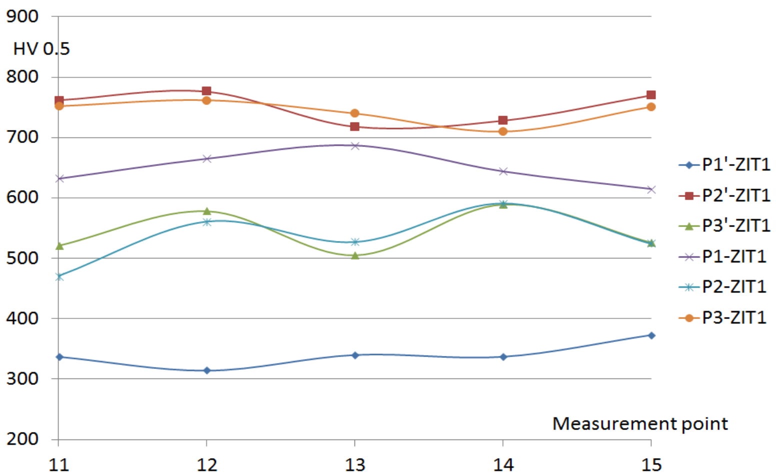


Figure 7. Variation of hardness – S2 - ZIT1 Area.

In case of ZIT2, S1 area, in the lower part of the figure 6, it can be seen that the maximum hardness values were obtained for the samples resulted through normal depositing by welding, P1 and the minimum values are obtained when using the WIG welding process and the normal technique of depositing. The low values obtained are explicable by lower heat into the material.

From analyzing the hardness obtained in area ZIT 1, area S2, top, figure 7, it can be seen that the highest values were obtained in the sample P2’, and the minimum values as one would expect in the case of the P1’.

From analysing the hardness values obtained in the median area, encoded with C2, figure 8 shows the maximum values obtained in the case of the sample P2 in the implementation of which we used the SMAW process of welding and Weld Toe Tempering Technique and the minimum values in the case of the P1’ realized by the procedure of normal depositing WIG.

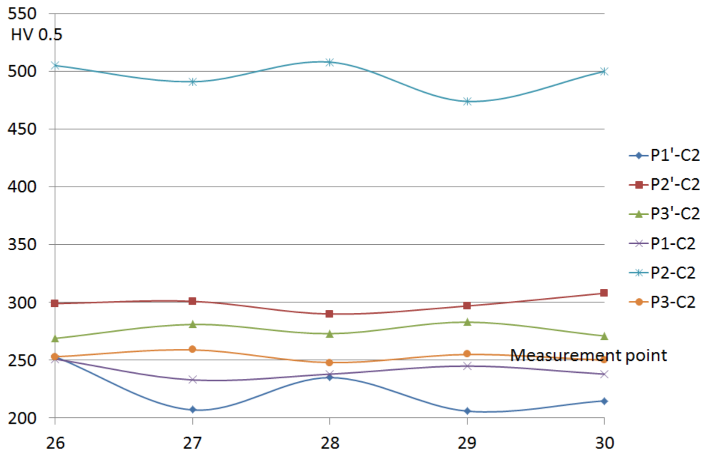


Figure 8. Variation of hardness - Area C2.

4. Conclusions

On the basis of the information in the paper, the following conclusions may be drawn:

- Both welding processes can be used for reconditioning by welding of the elements associated with crankshafts in the automotive industry;
- The layers layout mode to restore the constructive shape, has a primary effect on hardness;
- Using the WIG process presents the major advantage of the introduction of a smaller heat quantities in the reconditioned part, so a more beneficial influence on hardness;
- The variations in hardness, for all 6 samples, are not linear;
- It is necessary to conduct research on the structure for a better correlation between the influence of techniques, procedures and delimitation of their applications.

Acknowledge

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