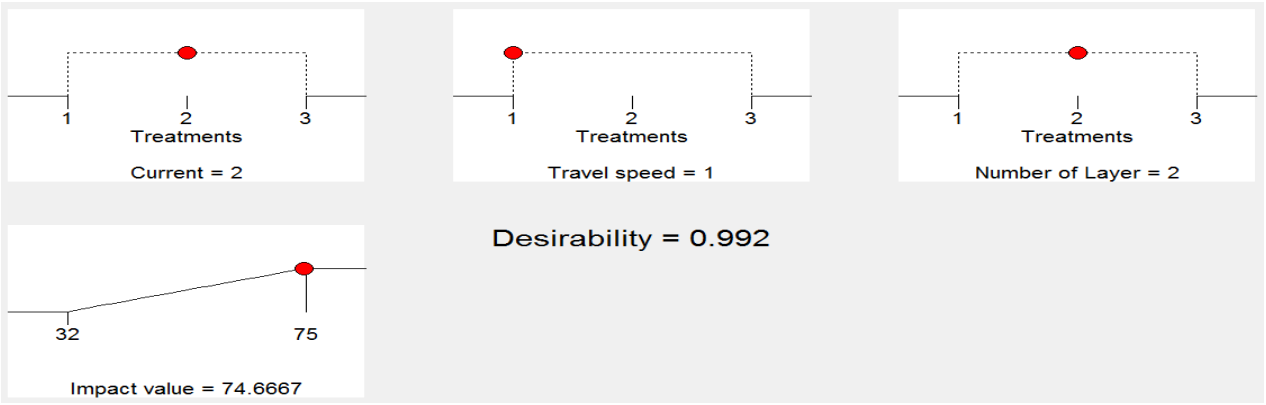

Figure 11 Ramp plot of optimized input settings

Chemical Analyses

The chemical analysis of all specimens was done by using spectra analyzer. It is known that the chemical analysis of any weld deposit is affected by dilution and pick up phenomena. Therefore, the element distribution throughout the weld deposit from the surface up to fusion line would be different.

Table 7 shows the chemical analysis of nine specimens. The attractive elements of of the tables are chromium, silicon, and manganese. Cr and Si are α stabilizer while Mn is γ stabilizer. All of them are working as solid solution strengthener. Moreover Cr is carbide forming element and at the same time shifts synchronously with Si & Mn the TTT (time temperature transformation) diagram to the left and hence ensure participation of hard and tough martensitic structure. The toughening effect is come from manganese.

As seen from table 7, the carbon percentage of the base metal is 0.15 % and because hardfacing process is fusion welding in nature, the dilution and pick up processes should be occurred. The pickup of carbon from the base metal to the weld deposit is clear in specimens 1, 6 and 8 because of one hardfacing layer. From the other side the weight percentage of chromium, silicon and manganese is less than corresponding nominal values of table 3. Due to chemical composition difference between base metal and electrode, the migration of Cr, Si, and Mn to the base metal is occurred. By looking to other specimenss, it can be noticed that chemical composition of electrode is near to the standard values because of these specimens were hardfaced with two and three layers respectively. In other word, the pickup of carbon and the dilution between base & weld metal is reduced.

Table 7 chemical composition of the hard weld deposit

Run	C%	Si%	Mn%	S%	P%	Cr%	Ni%	V%	Mo%
1	0.14	0.632	0.585	0.01843	0.01164	2.48	0.06919	0.0123	0.00974
2	0.11	0.863	0.753	0.01446	0.02016	2.812	0.0117	0.01363	0.00639
3	0.1003	0.987	0.788	0.02812	0.02086	3.183	0.01243	0.01266	0.00921
4	0.118	0.791	0.731	0.022	0.01796	2.77	0.01318	0.01064	0.01075
5	0.101	0.972	0.783	0.02076	0.01829	3.172	0.01296	0.00664	0.01068
6	0.12	0.881	0.712	0.01446	0.02016	2.703	0.0117	0.01363	0.00639
7	0.1006	0.965	0.781	0.02196	0.01681	3.115	0.01162	0.00932	0.01198
8	0.12	0.725	0.603	0.01945	0.01771	2.665	0.01268	0.01113	0.00764
9	0.101	0.881	0.781	0.0122	0.01793	2.983	0.00882	0.00751	0.00773
Run	**Cu%**	**Ti%**	**Sn%**	**Co%**	**Zn%**	**W%**	**Zr%**	**Nb%**	**Fe%**
1	0.00831	0.00382	0.04533	0.01754	0.02468	0.00307	0.00008	0.0035	Balance
2	0.00504	0.04105	0.01823	0.02468	0.0038	0.00601	0.00008	0.00106	Balance
3	0.0069	0.02619	0.02833	0.02195	0.00208	0.00988	0.00078	0.00021	Balance
4	0.00719	0.0455	0.02637	0.02128	0.00011	0.00928	0.00029	0.00269	Balance
5	0.00449	0.02185	0.0265	0.06881	0.00342	0.00911	0.00077	0.00069	Balance
6	0.00504	0.04105	0.01823	0.02468	0.00336	0.0001	0.0038	0.00601	Balance
7	0.00689	0.01817	0.03099	0.03361	0.0023	0.01196	0.00015	0.00029	Balance
8	0.00437	0.02074	0.02619	0.02243	0.00559	0.00006	0.00317	0.00911	Balance
9	0.00506	0.02847	0.02031	0.05309	0.00253	0.00606	0.00032	0.0007	Balance

Hardness Results

By going to the hardness results that are shown in figure 12, the profile of the specimens is different from each to other due to different setting of input parameters. The profile consists of three zones; namely: weld deposit, heat affected zone, and the base metal. The disturbance of hardness profile across HAZ zone of the specimens 1, 6,&8 that hardfaced with only one layer, is returned to the heterogeneous variety of the chemical analysis due to pick up and dilution. Conversely, the profile is relatively going down smoothly for the two and three layers specimens. This could be attributed to the second layer which plays as self-tempering for the first weld deposit and HAZ zone.

All the specimens produced martensitic structures (Figgure 13) with chemical compositions and hardness as it is mentioned above. This hard structure is produced during air cooling due to alloying elements of chromium, silicon, and manganese respectively. Hence the weld deposit is air hardenable and it can be hardened more deep by heat treatment.

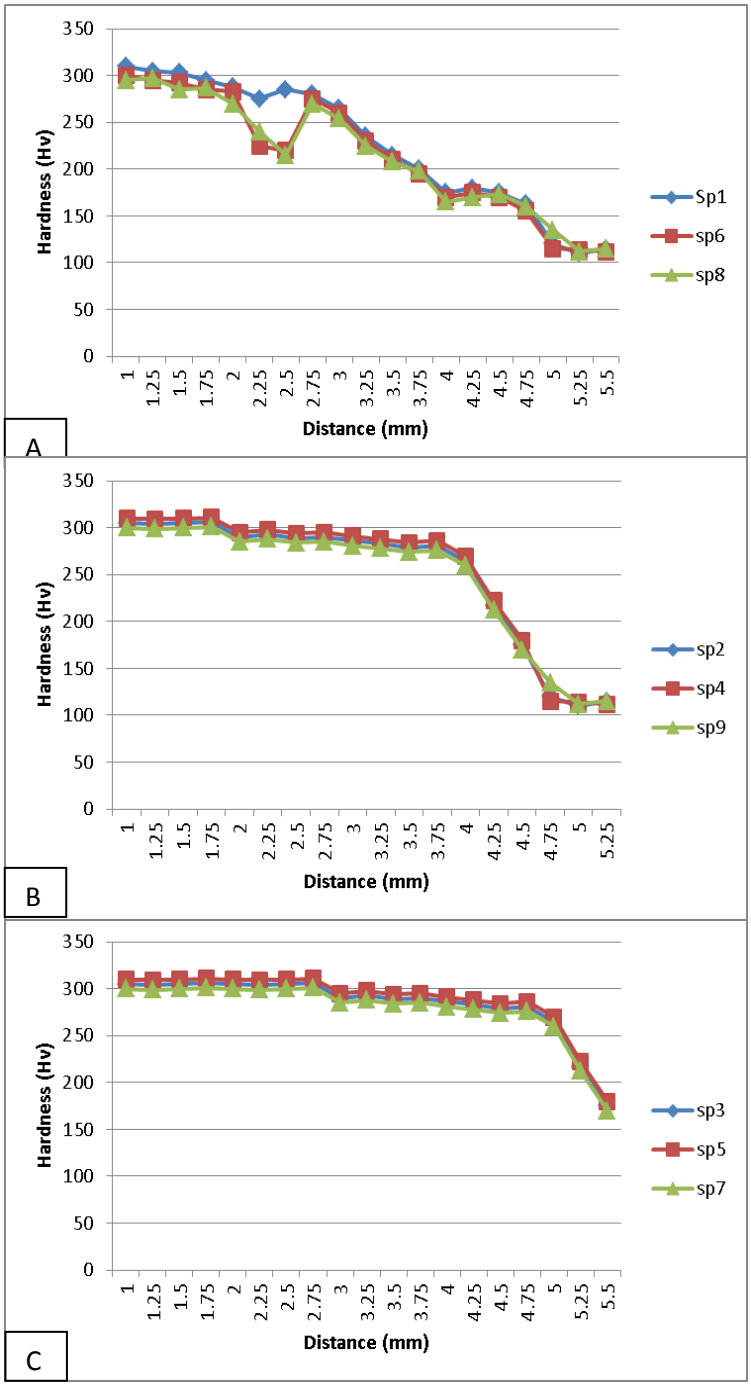

Figure 12 Hardness profile

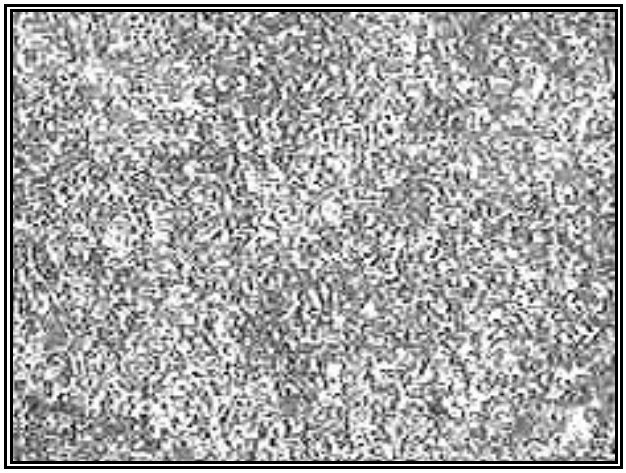

Figure 13 microstructure of weld deposit

CONCLUSIONS

Based on the results discussion and analysis, the following conclusions can be drawn:

1. The low carbon steel is successfully hardfaced with E1-UM 300 electrode
2. The hardfacing with one layer should be avoided because it gave low impact resistance
3. The optimum settings of hardfacing parameters are: current 245 Amp, travel speed 90 mm/min, and two hardfacing layers.
4. Fast speed is also must be avoided
5. The hardness profile of two and three layers are better than one layer which expresses disturbance at the HAZ zone.

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