Experimental study of Tool Overhang on Surface Roughness during Turning Process

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In the turning process, the importance of machining parameter choice is increased, as it controls the surface quality required. Tool overhang is a cutting tool parameter that has not been investigated in as much detail as some of the better known ones.

It is appropriate to keep the tool overhang as short as possible; however, a longer tool overhang may be required depending on the geometry of the work piece and when using the hole-turning process in particular. In this study, we investigate the effects of changes in the tool overhang in the external turning process on both the surface quality of the work piece and tool wear. For this purpose, we used work pieces of AISI 1050 material with diameters of 20, 30, and 40 mm; and the surface roughness of the work piece and tool wear were determined through experiments using constant cutting speed and feed rates with different depth of cuts (DOCs) and tool overhangs. We observed that the effect of the DOC on the surface roughness is negligible, but tool overhang is more important. The deflection of the cutting tool increases with tool overhang.

Two different analytical methods were compared to determine the dependence of tool deflection on the tool overhang. Also, the real tool deflection values were determined using a comparator. We observed that the tool deflection values were quite compatible with the tool deflection results obtained using the second analytical method.

EXPERIMENTAL SETUP

In this study, we selected the work piece diameter, DOCs and tool overhang as variable experimental parameters and measured the surface roughness of the work piece and cutting tool wear. Our experimental studies were carried using a conventional lathe. As the cutting tool, we used P10 grade-coated sintered carbide and HSS inserts (the standard DNMG150608 and PDJNR2525 type tool holders) in dynamometer. The work pieces used in the experiments were 20, 30, and 40 mm in diameter. The literature survey provided information about selection of the work piece diameter, and these values lay in the range 25–100 mm. In the present study, we selected work pieces of materials and diameters that are widely used in industrial applications. We used We used a tailstock to prevent deflection of slender work pieces during machining operations, and the work piece length was kept short to establish a more rigid setup. As the work piece material, we selected the quite commonly preferred steel in the manufacturing industry, AISI 1050. This material contains 0.48–0.55% C, 0.17% Mn, and 0.69% Si, and has a hardness value of between 175 and 207 HV, depending on the applied heat treatment. The tool overhang lengths were 30 and 34 mm. The DOCs we selected were 0.5 and 1.0 mm. The cutting speed and feed rate were selected as 170 m/min and 0.045 mm/rev (at constant values), respectively. The external turning processes were carried out using the anticipated parameters.

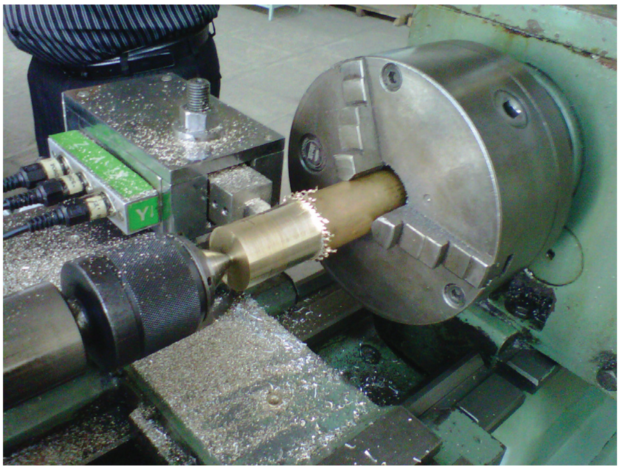


Fig 2.1. Turning process

Figure2.2. Surface Roughness testing machine

Research Methods and Procedures

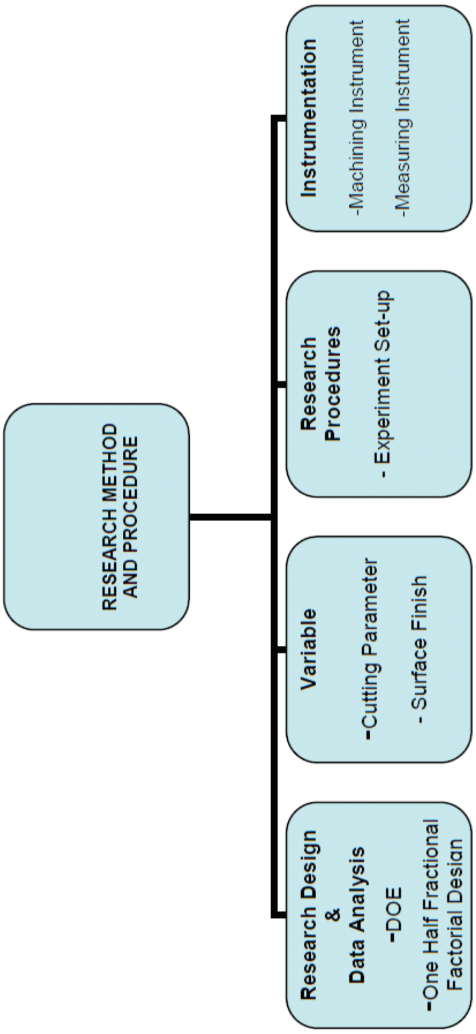


Figure 3.1 Overall research methodology

DYNAMOMETER

The dynamometer can measure 3 forces in mutually perpendicular directions, i.e. horizontal, vertical and thrust, and is provided with 3 connector sockets.

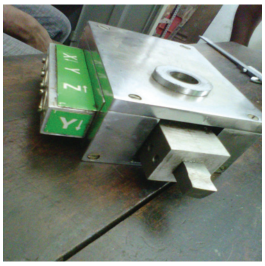


Fig 4.1 Lathe Tool Dynamometer

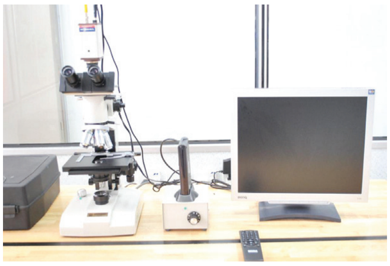
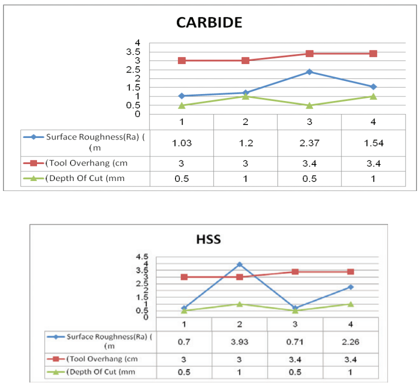


Fig4.2 microscope

Results

Following are the graphs which denote the Surface Roughness (Ra) based on tool overhang and tool deflection



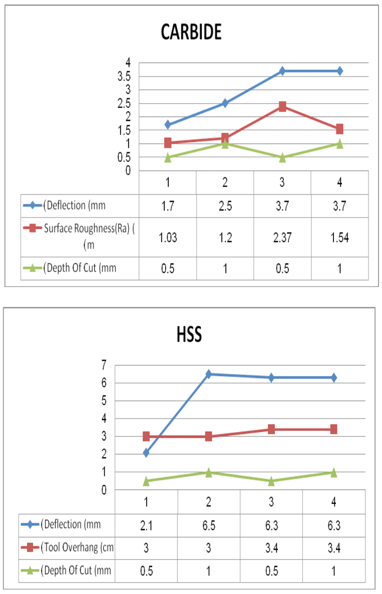
CARBIDE

	1	2	3	4
Surface Roughness(Ra) ((m	1.03	1.2	2.37	1.54
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

HSS

	1	2	3	4
Surface Roughness(Ra) ((m	0.7	3.93	0.71	2.26
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

5.1.1 Surface Roughness (Ra) for different diameters of Aluminium. Graphs for Aluminium 40mm of surface roughness (Ra) Vs tool overhang



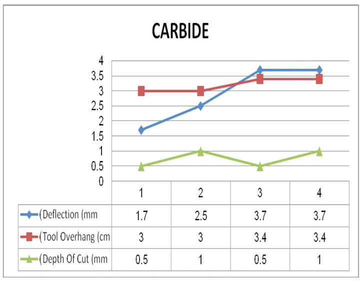
CARBIDE

	1	2	3	4
(Deflection (mm	1.7	2.5	3.7	3.7
Surface Roughness(Ra) ((m	1.03	1.2	2.37	1.54
(Depth Of Cut (mm	0.5	1	0.5	1

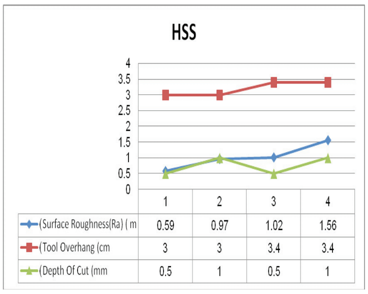
HSS

	1	2	3	4
(Deflection (mm	2.1	6.5	6.3	6.3
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

5.1.2. Graphs for Aluminium 40mm of surface roughness (Ra) Vs deflection

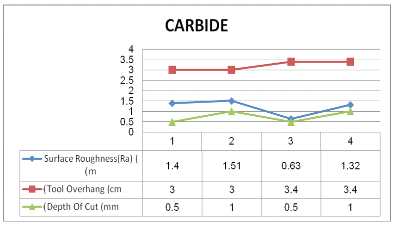


	1	2	3	4
(Deflection (mm	1.7	2.5	3.7	3.7
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

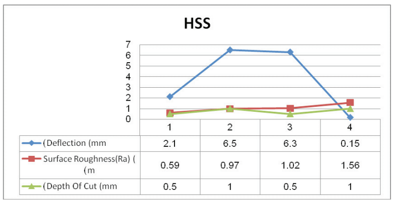


	1	2	3	4
(Surface Roughness(Ra) (m	0.59	0.97	1.02	1.56
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

5.1.3. Graphs for Aluminium 40mm of Tool overhang Vs deflection

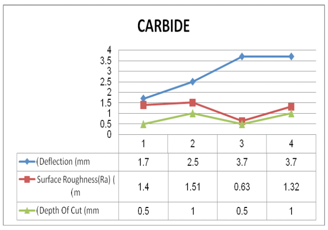


	1	2	3	4
Surface Roughness(Ra) ((m	1.4	1.51	0.63	1.32
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

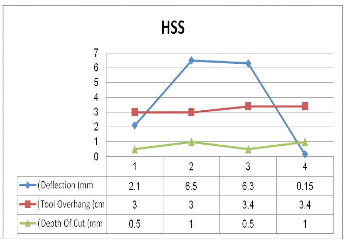


	1	2	3	4
(Deflection (mm	2.1	6.5	6.3	0.15
Surface Roughness(Ra) ((m	0.59	0.97	1.02	1.56
(Depth Of Cut (mm	0.5	1	0.5	1

5.1.4.Graphs for Aluminium 30mm of surface roughness (Ra) Vs tool overhang

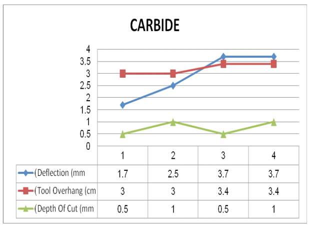


	1	2	3	4
(Deflection (mm	1.7	2.5	3.7	3.7
Surface Roughness(Ra) ((m	1.4	1.51	0.63	1.32
(Depth Of Cut (mm	0.5	1	0.5	1

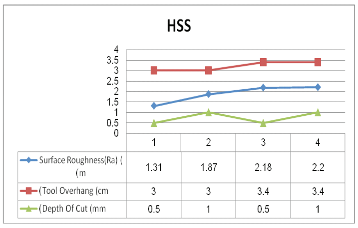


	1	2	3	4
(Deflection (mm	2.1	6.5	6.3	0.15
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

5.1.5.Graphs for Aluminium 30mm of surface roughness (Ra) Vs deflection

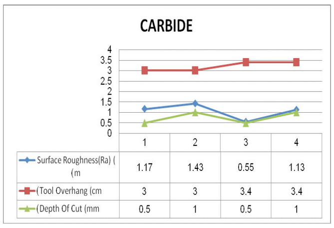


	1	2	3	4
(Deflection (mm	1.7	2.5	3.7	3.7
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1



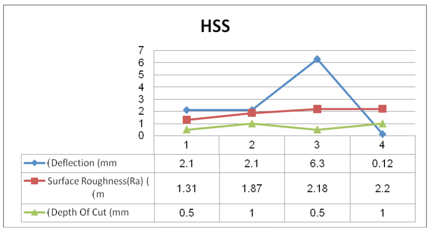
	1	2	3	4
Surface Roughness(Ra) ((m	1.31	1.87	2.18	2.2
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

5.1.6.Graphs for Aluminium 30mm of surface roughness (Ra) Vs deflection

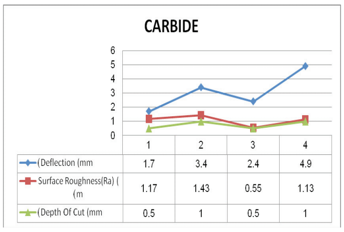


	1	2	3	4
Surface Roughness(Ra) ((m	1.17	1.43	0.55	1.13
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

5.1.7. Graphs for Aluminium 20mm of surface roughness (Ra) Vs Tool overhang

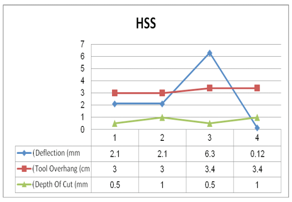


	1	2	3	4
(Deflection (mm	2.1	2.1	6.3	0.12
Surface Roughness(Ra) ((m	1.31	1.87	2.18	2.2
(Depth Of Cut (mm	0.5	1	0.5	1

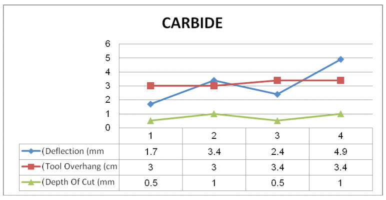


	1	2	3	4
(Deflection (mm	1.7	3.4	2.4	4.9
Surface Roughness(Ra) ((m	1.17	1.43	0.55	1.13
(Depth Of Cut (mm	0.5	1	0.5	1

5.1.8. Graphs for Aluminium 20mm of surface roughness (Ra) Vs deflection

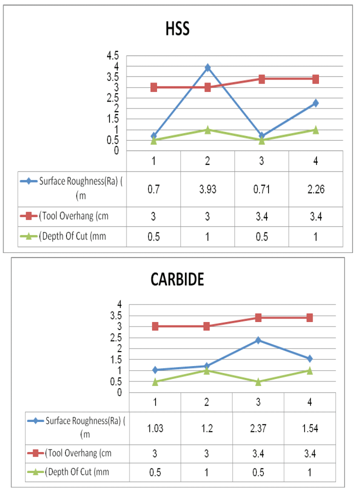


	1	2	3	4
(Deflection (mm	2.1	2.1	6.3	0.12
(Tool Overhang (cm	3	3	3.4	3.4
(Depth Of Cut (mm	0.5	1	0.5	1

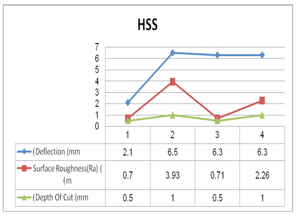


5.1.9. Graphs for Aluminium 20mm of Tool overhang Vs deflection

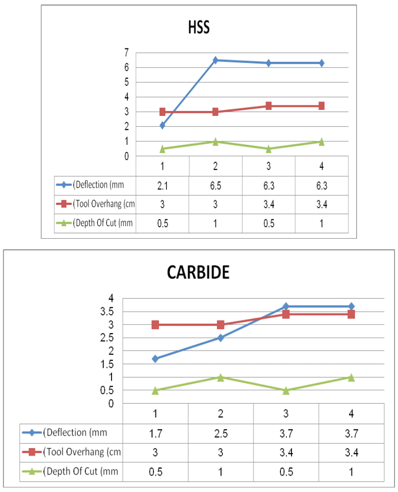
5.2 Surface Roughness (Ra) for different diameters of Brass



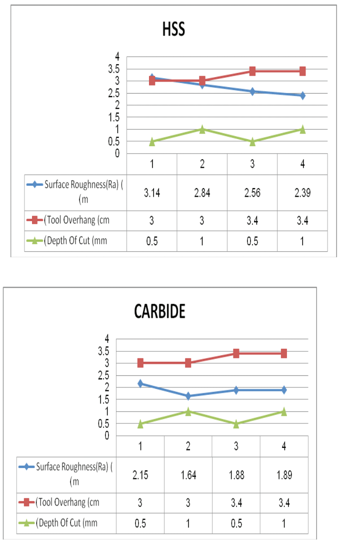
5.2.1. Graphs for Brass 40mm of Tool overhang Vs Surface Roughness



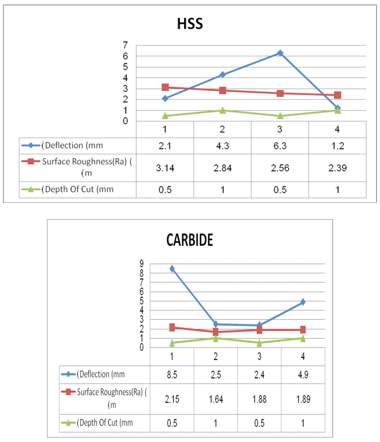
5.2.2. Graphs for Brass 40mm of Deflection Vs Surface Roughness



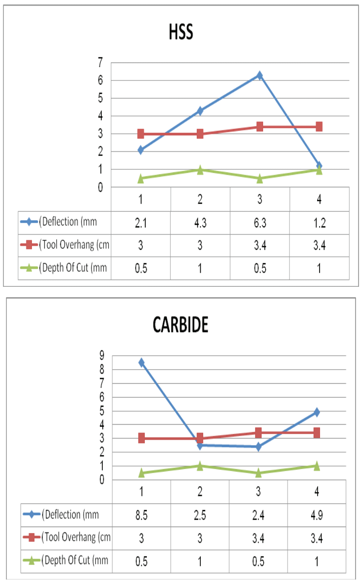
5.2.3. Graphs for Brass 40mm of Deflection Vs Tool overhang



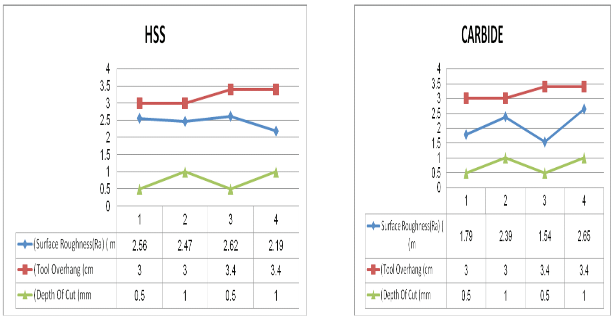
5.2.4. Graphs for Brass 30mm of Deflection Vs Tool overhang



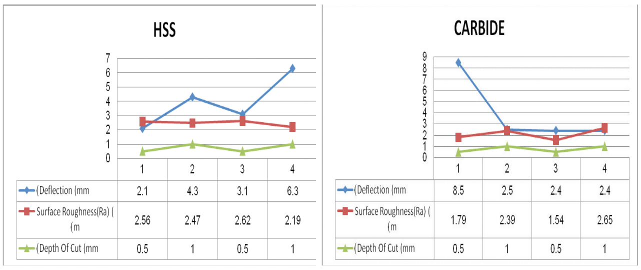
5.2.5. Graphs for Brass 30mm of Deflection Vs Surface Roughness (Ra)



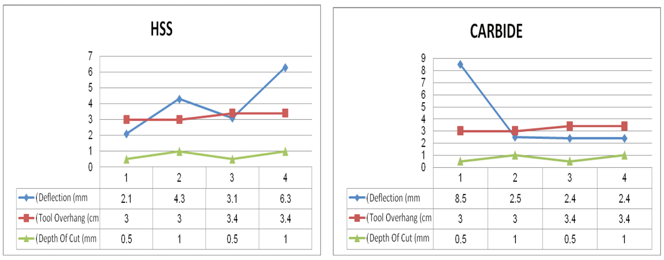
5.2.6. Graphs for Brass 30mm of Deflection Vs Tool Overhang



5.2.7. Graphs for Brass 20mm of Surface Roughness (Ra) Vs Tool Overhang

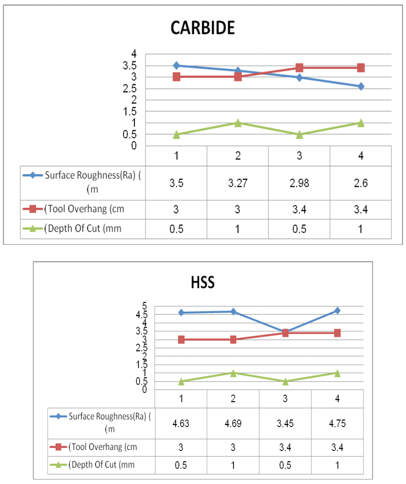


5.2.8. Graphs for Brass 20mm of Surface Roughness (Ra) Vs Deflection

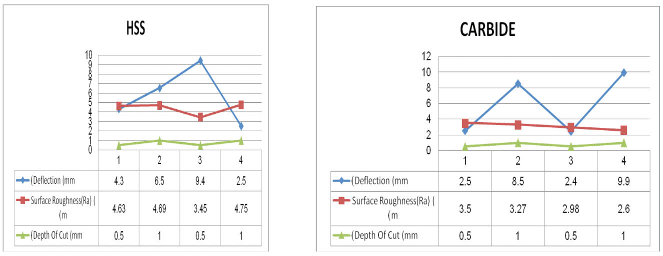


5.2.9. Graphs for Brass 20mm of Tool overhang Vs Deflection

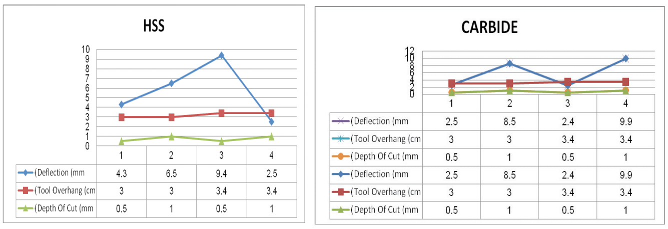
5.3 Surface Roughness (Ra) for different diameters of Mild Steel



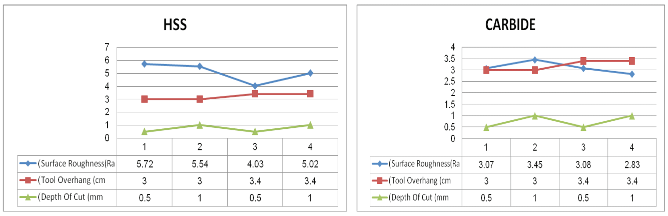
5.3.1. Graphs for Mild Steel 40mm of Tool overhang Vs Surface Roughness (Ra)



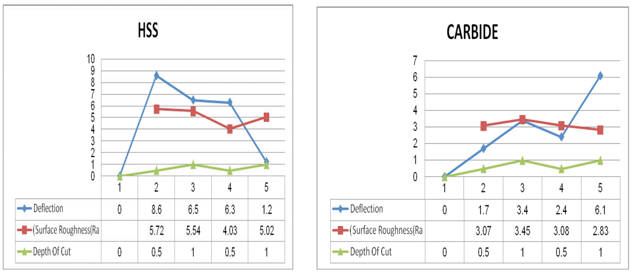
5.3.2. Graphs for Mild Steel 40mm of Deflection Vs Surface Roughness (Ra)



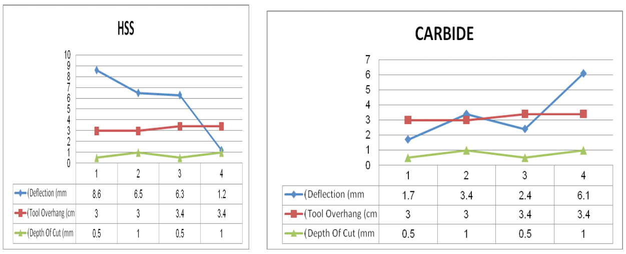
5.3.3. Graphs for Mild Steel 40mm of Deflection Vs Tool Overhang



5.3.4. Graphs for Mild Steel 40mm of Surface Roughness (Ra) Vs Tool Overhang



5.3.5. Graphs for Mild Steel 40mm of Surface Roughness (Ra) Vs Deflection



5.3.6. Graphs for Mild Steel 40mm of Tool Overhang Vs Deflection

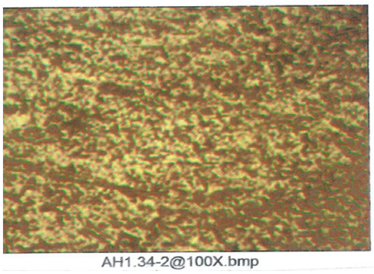


Figure 5.3.7. Microstructure of Aluminium 40mm Brass 40mm machined by HSS

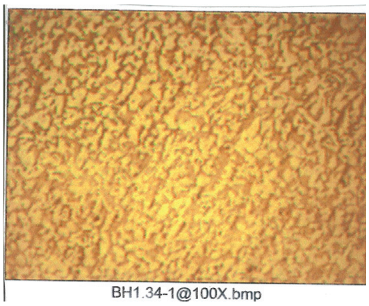


Figure 5.3.8.Microstructure of Aluminium 40mm machined by Carbide

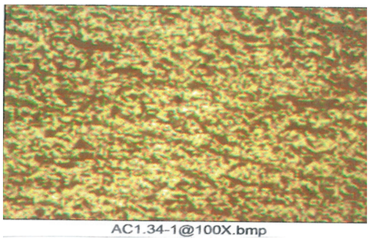


Figure 5.3.9Microstructure of machined by HSS

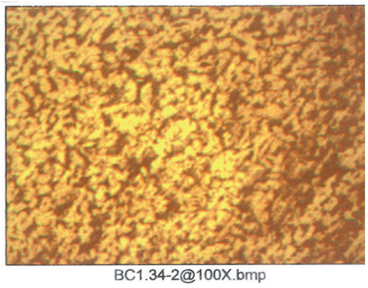


Figure 5.4.0 Microstructure of Brass 40mm machined my Carbide

CONCLUSION

In this study, we investigated the effects of the changes in tool overhang on the surface quality of the work piece, its microstructure and deflection of the tool experimentally.

1. From the experiments performed on the anticipated machining parameters, we observed that the surface roughness of work piece increases as the tool overhang increases.
2. Using the same tool overhang, the surface roughness of the work piece increases as the DOC increases. These results are compatible with the literature.
3. In the measurements performed after the experiments were complete, we observed that the cutting tool deflection values increased as the tool overhang increased.
4. Depth of cut parameter doesn't effect to much on surface finish.
5. The results also revealed that using a long tool length may set excessive vibrations that could be efficiently controlled by the use of short tool length. With a long tool length, the cutting variables become important factors to control in order to significantly improve surface roughness results no matter what type of bar is used.

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