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Comparison of Abrasive Wear of Mild Steel and Hard facing Alloy

P. B. Dhotrad1, D. G. Sondur, M. D. Harlapur, Dr. M. Rajaram Narayanan
Department of Mechanical Engineering, Rural Engineering College, Hulkoti, 582205, Karnataka, India

Abstract Wear is a process of removal of material from one or both of two solid surfaces in solid state contact, occurring when two solid surfaces are in sliding or rolling motion together. Abrasive wear occurs when a harder material is rubbing against a softer material. Abrasion is the wearing away of surfaces by rubbing, grinding, or other types of friction. It usually occurs when a hard material is used on a softer material. Hardfacing is one of the versatile techniques that can produce the hard and wear resistant surface layer of various metals and alloys on metallic substrate. It not only helps them withstand wear, but also helps to prevent corrosion and high temperature oxidation. In the present study, sample of 75x26x12 mm size were used for testing as per ASTMG65 standards. Specimens were ground using surface grinder to make the surface flat. Before the abrasive wear test all the specimens were cleaned with acetone and then weighed on an electronic balance with an accuracy of ± 0.001 gm. The three-body abrasive wear test were conducted using a dry sand/rubber wheel abrasion tester as per ASTM G65. The experiments were carried out for different loads 1, 2, 3 & 4 kgf on the load hanger.. It is found that low percentage of carbon and high percentage of chromium will enhance wear resistance. Volumetric wear loss is maximum at higher load and at higher speed

Keywords: Abrasive wear, Hardfacing, Volumetric wear loss

1. Introduction Surface modification techniques are used to enhance the service life of several engineering components. Surfacing is one of such techniques; where in a superior material is deposited over industrial components, by welding, to enhance surface characteristics. Material loss due to wear in various industries is significantly high. All these components face the problem of wear, before put into services, are given a surface hardening treatment or a protective coating with wear resistance materials of various types, depending upon its service conditions. After a period of service these components will get reduced in size because of wear and can no longer be used. So these components either have to be rebuilt or rejected. Rebuilding of these components to the required size by the welding can save the cost tremendously. Surfacing is a cost effective and proven method of depositing protective coating. The effect of surfacing on component life and performance will depend upon the surfacing material and the application process. Hardfacing is one of the versatile techniques that can produce the hard and wear resistant surface layer of various metals and alloys on metallic substrate. It not only helps them withstand wear, but also helps to prevent corrosion and high temperature oxidation. Hardfacing is commonly employed method to improves surface properties of agricultural tools, components for mining operations, soil preparation equipments and others. An alloy is homogeneously deposited on the surface of a soft material (usually low or medium carbon steels) by welding with the purpose of increasing the

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hardness and wear resistance without significant loss in ductility and toughness of the substrate. The hardfacing technique in the mean time has grown into a well-accepted industrial technology. Due to continuous rise in the coat of materials has well as increased material requirements; the hardfacing has been into prominence in the last few decades.

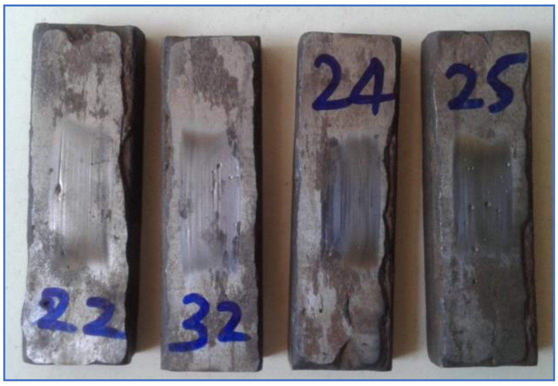
2. Experimental Description Dry abrasion tester measures index of abrasive resistance to dry sand. The Dry Sand / Rubber Wheel Abrasion test involves abrading of test specimen with a grit of controlled size and composition. The test specimen is pressed against a rotating wheel, while a controlled flow of grit abrades test surface. The rotation of the wheel is along the sand flow. The duration of test and force applied is varied. Specimens are weighed before and after the test. Loss in mass is recorded. It is necessary to convert mass loss to volume loss. due to differences in density of materials. Index of abrasion is reported as loss of volume. Wheel rim is of chlorobutyle rubber with shore hardness of A60±2.

Specifications**:** Speed : 200 RPM , Wheel diameter :228.6 mm.

Test Load: 4.5 to 13.25 kgf, Instrumentation: 4 digit preset counter to stop test after preset revolution count. Power: 230V / 50Hz/ Single phase / 1.5 KVA

3. Methodology In the present study, sample of 75x26x12 mm size were used for testing as per ASTMG65 standards. Specimens were ground using surface grinder to make the surface flat. Before the abrasive wear test all the specimens were cleaned with acetone and then weighed on an electronic balance with an accuracy of ± 0.001 gm. The three-body abrasive wear test were conducted using a dry sand/rubber wheel abrasion tester as per ASTM G65.The sand particles of mesh size 50 to 80 are used as abrasives and they were angular in shape with sharp edges. The sand particles were sieved (size200–250 μm), cleaned and dried.

Mild steel specimen



Hardfaced specimen

Fig.1 test specimen

In this test, samples were held against a rotating rubber wheel under the constant flow of abrasives in between the sample and the rubber wheel under predetermined load. In the present study, silica sand was used as the abrasive. The abrasive particles of grade silica sand were angular in shape with sharp edges. The abrasive was fed at the contacting face between the rotating rubber wheel and the test sample. The tests were conducted at a rotational speed of 50 to 200 rpm. The flow rate of the abrasive was 370 g/min. The sample was cleaned with acetone and then dried. Its initial weight was determined in a high precision digital balance (0.001gm accuracy) before it was mounted in the sample holder. The abrasives were introduced between the test specimens and rotating abrasive wheel composed of chlorobutyl rubber tyre. The diameter of the rubber wheel used was228 mm. The test specimen was pressed against the rotating wheel at a specified force by means of lever arm while a controlled flow of abrasives abrades the test surface. The rotation of the abrasive wheel was such that its contacting face moves in the direction of sand flow. The pivot axis of the lever arm lies within a plane, which was approximately tangent to the rubber wheel surface and normal to the horizontal diameter along which the load was applied. At the end of a set test duration, the specimen was removed, thoroughly cleaned and again weighed (final weight). The difference in weight before and after abrasion was determined. Four tests were performed and the average values so obtained were used in this study. The experiments were carried out for different loads 1, 2, 3 & 4 kgf on the load hanger

4. Results and discussion The chemical composition of the hardfacing alloy is given in Table.1 and the chemical composition of mild steel is given in Table.2

Table 1.Chemical composition for hardfacing alloy

Element	Carbon	Silicon	Manganese	Phosphorous	Sulphur	Chromium	Nickel	Molybdenum
%	0.0610	0.364	0.265	0.022	0.014	6.630	0.078	0.510

Table 2. Chemical composition for mild steel

Element	Carbon	Silicon	Manganese	Phosphorous	Sulphur	Chromium	Nickel	Molybdenum
%	0.0610	0.063	0.820	0.013	0.012	0.021	0.024	0.510

Table-3 gives the observations made during the conduct of **wear** tests on dry abrasion tester using specimen of Hardfacing material.. Table.4 gives the observations made during the conduct of test on dry abrasion tester using mild steel specimen. The wear tests on both specimen were conducted at constant speed and varying the loads

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Table-3 Hardfaced specimen at constant speed and varying load

Sample No.	Speed RPM	Load in N	Time Minutes	Initial weight (gms)	Final weight (gms)	Weight Loss (gms)	Volumetric loss(mm^3) X 10^{-7}	Volumetric loss (mm^3) per unit
1-1	200	9.81	5	164.64	164.52	0.12	15.846	3.0769
1-2	200	19.62	5	179.087	178.927	0.16	20.5128	4.1025
1-3	200	29.43	5	179.499	179.319	0.18	23.0769	4.6153
1-4	200	39.24	5	169.942	169.732	0.21	26.923	5.3846
2-1	150	9.81	6.67	182.515	182.443	0.072	9.2307	1.3839
2-2	150	19.62	6.67	178.246	178.116	0.08	10.2564	1.5376
2-3	150	29.43	6.67	178.447	178.347	0.1	12.8205	1.9221
2-4	150	39.24	6.67	180.029	179.919	0.11	14.102	2.1143
3-1	100	9.81	10	171.741	171.683	0.058	7.4358	0.7453
3-2	100	19.62	10	179.541	179.919	0.062	7.948	0.7948
3-3	100	29.43	10	173.624	173.559	0.065	8.333	0.8333
3-4	100	39.24	10	180.571	180.501	0.07	8.9743	0.8974
4-1	50	9.81	20	180.973	180.925	0.048	6.1538	0.3076
4-2	50	19.62	20	176.094	176.043	0.051	6.5384	0.3269
4-3	50	29.43	20	175.556	175.5	0.056	7.1794	0.3589

4-4	50	39.24	20	175.78	175.72	0.061	7.5621	0.3872

Table-4 mild steel specimen at constant speed and varying load

Sample No.	Speed RPM	Load in N	Time Minutes	Initial weight (gms)	Final weight (gms)	Weight Loss (gms)	Volumetric loss(mm^3) X 10^{-7}	Volumetric loss (mm^3) per unit
1-1	200	9.81	5	164.52	164.162	0.358	45.897	9.179
1-2	200	19.62	5	178.927	178.527	0.4	51.282	10.256
1-3	200	29.43	5	179.319	178.849	0.47	60.256	12.051
1-4	200	39.24	5	169.732	169.227	0.505	64.743	12.948
2-1	150	9.81	6.67	182.443	182.223	0.22	28.205	4.228
2-2	150	19.62	6.67	178.116	177.916	0.25	32.051	4.805
2-3	150	29.43	6.67	178.347	178.067	0.28	35.897	5.381
2-4	150	39.24	6.67	179.919	179.619	0.3	38.461	5.776
3-1	100	9.81	10	171.683	171.553	0.13	16.667	1.667
3-2	100	19.62	10	179.919	179.312	0.14	17.948	1.794
3-3	100	29.43	10	173.559	173.447	0.112	14.358	1.435
3-4	100	39.24	10	180.501	180.303	0.198	25.384	2.538
4-1	50	9.81	20	180.925	180.875	0.05	6.41	0.321
4-2	50	19.62	20	176.043	175.963	0.08	10.256	0.512
4-3	50	29.43	20	175.5	175.4	0.1	12.82	0.641

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4-4	50	39.24	20	175.72	175.6	0.12	15.384	0.769

From the above tabulated observations different graphs are plotted for hardfaced samples & mild steel samples

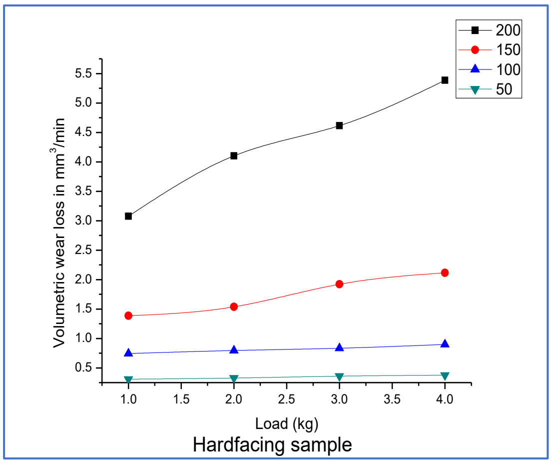


Fig.2 Load v/s volumetric wear loss

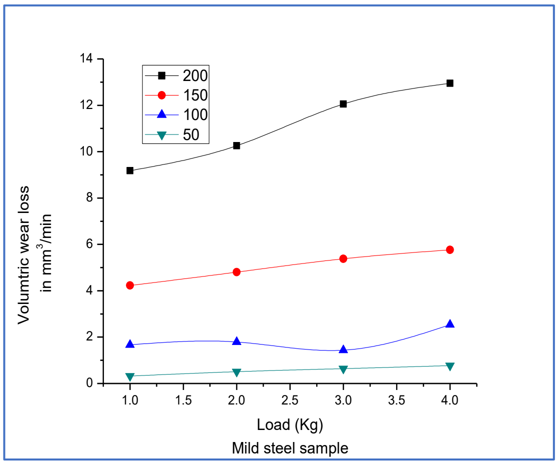
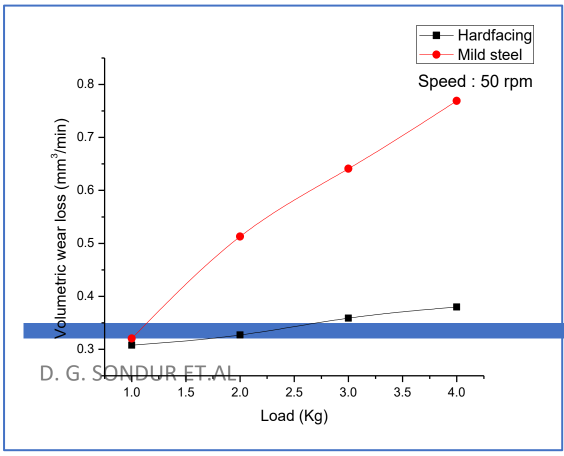


Fig.3 Load v/s volumetric wear loss

Fig.2 indicates the variation in volumetric wear loss of hardfaced samples with the variation in the load and Fig.3 indicates the change in volumetric wear loss of mild steel samples with the variation in the load



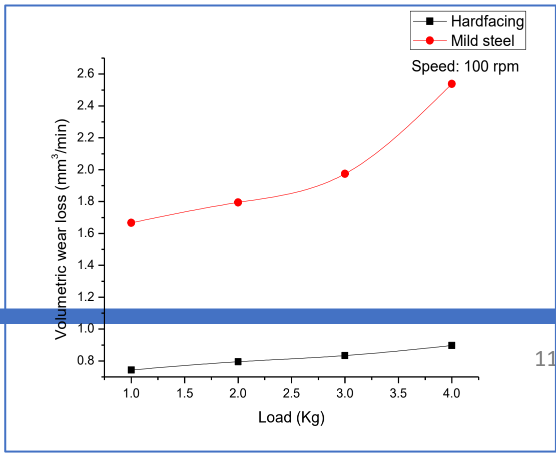


Fig.4Load-volumetric wear loss

Fig.5 Load v/s volumetric wear loss

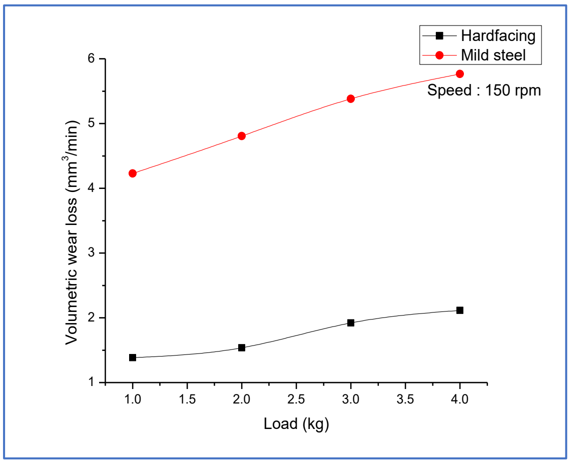


Fig.6 Load v/s volumetric wear loss

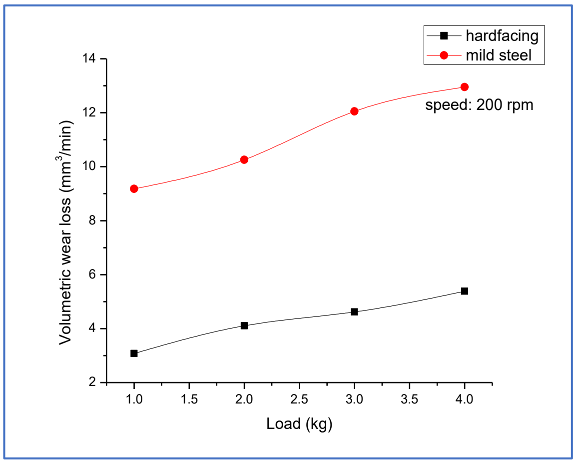


Fig.7 Load v/s volumetric wear loss

The graph shown in fig.-4,5,6 & 7 indicate the variation in volumetric wear loss at different speeds 50 rpm, 100 rpm, 150 rpm & 200 rpm respectively hardfaced samples & mild steel samples

5. Conclusion It is clearly found from the above testing that the volumetric wear loss is maximum at higher load and at higher speed for both mild steel samples and hardfaced samples. mild steel wears out at a very rapid rate than the hardface alloy.

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