

Table 1 – Dataset of the model

Sr. No	Co efficient of Friction						
	Input for Model					Output for model	
	Laminated Scheme	Thickness of Plate (mm)	Speed (rpm)	Force (Kg)	Time (s)	Co efficient of friction	Wear
1	45-0-0-45	10	500	5	0.0000	0.0265	0.0000
2	45-0-0-45	10	500	5	1.6790	0.0004	-0.1282
3	45-0-0-45	10	500	5	1.7422	0.0019	-0.0462
4	45-0-0-45	10	500	5	2.3429	0.0034	-0.5795
5	45-0-0-45	10	500	5	2.6703	0.0065	-0.4564
6	45-0-0-45	10	500	5	2.6746	0.0049	-0.3744
7	45-0-0-45	10	500	5	2.7333	0.0080	-0.2513
8	45-0-0-45	10	500	5	2.7963	0.0095	-0.7026
9	45-0-0-45	10	500	5	3.0611	0.0110	-0.9031
10	45-0-0-45	10	500	5	3.5946	0.0125	-1.1949
343	45-0-0-45	10	500	10	0.4707	0.0863	-0.3590
344	45-0-0-45	10	500	10	1.6140	0.0015	-2.7692
345	45-0-0-45	10	500	10	1.9502	0.0043	-1.4359
346	45-0-0-45	10	500	10	2.0175	0.0100	-3.9487
347	45-0-0-45	10	500	10	2.0175	0.0072	-5.0769
348	45-0-0-45	10	500	10	2.0847	0.0128	-6.3590
349	45-0-0-45	10	500	10	2.1520	0.0157	-6.7692
350	45-0-0-45	10	500	10	2.2192	0.0185	-7.1795
351	45-0-0-45	10	500	10	2.3537	0.0213	-8.3077
352	45-0-0-45	10	500	10	2.6227	0.0240	-8.5128

820	45-0-0-45	10	500	15	185.7430	0.2969	-11.5670
821	45-0-0-45	10	500	15	186.6850	0.3004	-14.6439
822	45-0-0-45	10	500	15	187.7610	0.3038	-14.0741
823	45-0-0-45	10	500	15	188.9040	0.3073	-13.5043
824	45-0-0-45	10	500	15	190.5180	0.3107	-16.0114
825	45-0-0-45	10	500	15	193.1410	0.3135	-15.8974
826	45-0-0-45	10	500	15	195.6960	0.3147	-16.9231
827	45-0-0-45	10	500	15	196.9070	0.3155	-16.0114
828	45-0-0-45	10	500	15	199.1260	0.3172	-17.3789
829	45-0-0-45	10	500	15	205.8510	0.3215	-18.5185
830	45-0-0-45	10	500	15	210.5580	0.3209	-18.9744
831	45-0-0-45	10	500	15	214.3910	0.3188	-19.4302
832	45-0-0-45	10	500	15	218.2250	0.3175	-19.4302
833	45-0-0-45	10	500	15	222.2600	0.3181	-20.5698
834	45-0-0-45	10	500	15	226.2270	0.3200	-20.3419
835	45-0-0-45	10	500	15	229.8590	0.3224	-20.5698
1413	45-0-0-45	10	500	20	821.2120	0.3486	-15.0997
1414	45-0-0-45	10	500	20	827.5480	0.3481	-13.8177
1415	45-0-0-45	10	500	20	835.5370	0.3502	-17.8063
1416	45-0-0-45	10	500	20	837.7410	0.3521	-16.3818
1417	45-0-0-45	10	500	20	842.7000	0.3548	-18.6610
1418	45-0-0-45	10	500	20	846.5560	0.3589	-19.9430
1419	45-0-0-45	10	500	20	847.9340	0.3593	-21.2251
1420	45-0-0-45	10	500	20	851.5150	0.3580	-19.9430
1421	45-0-0-45	10	500	20	856.1980	0.3626	-23.0769
1422	45-0-0-45	10	500	20	860.3310	0.3646	-23.3618
1423	45-0-0-45	10	500	20	863.9120	0.3636	-25.0712
1424	45-0-0-45	10	500	20	866.6670	0.3630	-25.0712

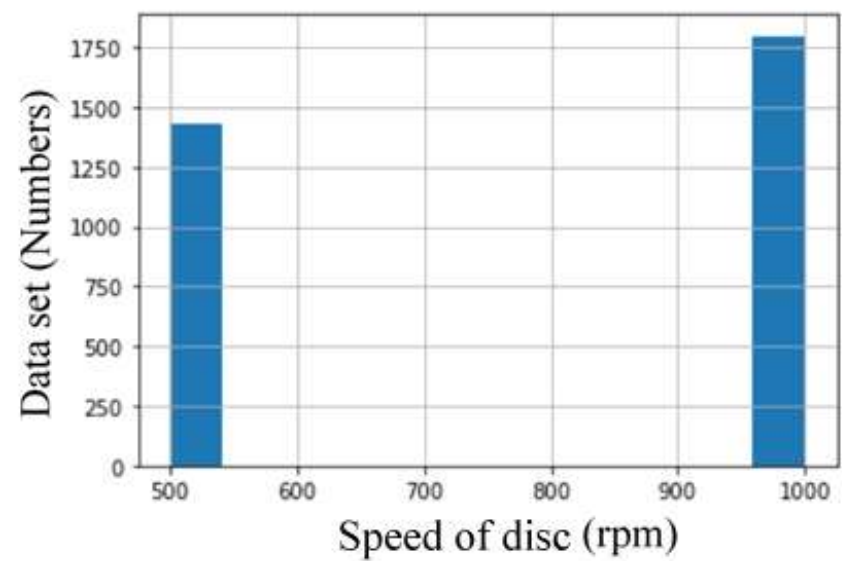
1425	45-0-0-45	10	500	20	869.1460	0.3621	-25.9259
1426	45-0-0-45	10	500	20	875.7580	0.3614	-27.6353
1427	45-0-0-45	10	500	20	880.1650	0.3647	-27.6353
1428	45-0-0-45	10	500	20	882.6450	0.3672	-28.9174
1429	45-0-0-45	10	500	20	885.6750	0.3674	-29.4872
1430	45-0-0-45	10	500	20	891.1850	0.3678	-30.1994
1431	45-0-0-45	10	500	20	893.9390	0.3723	-30.0570
1432	45-0-0-45	10	500	20	896.4190	0.3754	-30.0570
1433	45-0-0-45	10	500	20	897.5210	0.3777	-30.3419
1434	45-0-0-45	10	1000	5	1.9802	0.0202	1.8234
1435	45-0-0-45	10	1000	5	1.9802	0.0184	2.6211
1436	45-0-0-45	10	1000	5	1.9802	0.0401	3.8177
1437	45-0-0-45	10	1000	5	2.2277	0.0581	3.6752
1438	45-0-0-45	10	1000	5	2.2277	0.0726	5.0427
1439	45-0-0-45	10	1000	5	2.2277	0.0635	3.9601
1440	45-0-0-45	10	1000	5	2.2277	0.0290	2.7635
1441	45-0-0-45	10	1000	5	2.2277	0.0436	2.9345
1442	45-0-0-45	10	1000	5	2.7228	0.0099	4.9858
1443	45-0-0-45	10	1000	5	2.7228	0.0549	4.6439
1444	45-0-0-45	10	1000	5	2.9703	0.0472	5.6695
1926	45-0-0-45	10	1000	10	41.0891	0.4466	-29.3333
1927	45-0-0-45	10	1000	10	41.8317	0.4546	-28.2849
1928	45-0-0-45	10	1000	10	42.3267	0.4506	-27.9202
1929	45-0-0-45	10	1000	10	42.8218	0.4492	-26.0513
1930	45-0-0-45	10	1000	10	43.3168	0.4528	-27.2821
1931	45-0-0-45	10	1000	10	43.5644	0.4512	-25.6866
1932	45-0-0-45	10	1000	10	43.8119	0.4539	-24.4558

1933	45-0-0-45	10	1000	10	44.8020	0.4568	-22.4046
1934	45-0-0-45	10	1000	10	46.2871	0.4581	-21.9487
1935	45-0-0-45	10	1000	10	46.7822	0.4590	-24.9117
1936	45-0-0-45	10	1000	10	49.0099	0.4623	-23.4074
1937	45-0-0-45	10	1000	10	50.9901	0.4641	-23.6353
1938	45-0-0-45	10	1000	10	51.2376	0.4623	-23.0883
1939	45-0-0-45	10	1000	10	55.1980	0.4605	-27.6923
1940	45-0-0-45	10	1000	10	56.6832	0.4614	-24.0000
1941	45-0-0-45	10	1000	10	59.1584	0.4605	-22.7692
1942	45-0-0-45	10	1000	10	60.6436	0.4623	-16.5242
3215	45-0-0-45	10	1000	15	1465.7900	0.2447	15.3846
3216	45-0-0-45	10	1000	15	1472.3900	0.2448	33.8462
3217	45-0-0-45	10	1000	15	1475.9100	0.2451	20.6496
3218	45-0-0-45	10	1000	15	1477.2300	0.2466	30.4957
3219	45-0-0-45	10	1000	15	1479.4300	0.2448	14.6325
3220	45-0-0-45	10	1000	15	1482.0700	0.2441	25.5726
3221	45-0-0-45	10	1000	15	1486.0300	0.2435	52.3077
3222	45-0-0-45	10	1000	15	1488.6700	0.2388	42.4615
3223	45-0-0-45	10	1000	15	1488.6700	0.2432	41.8462
3224	45-0-0-45	10	1000	15	1489.1100	0.2413	48.0000
3225	45-0-0-45	10	1000	15	1493.0700	0.2394	52.9231
3226	45-0-0-45	10	1000	15	1493.0700	0.2410	51.6923
3227	45-0-0-45	10	1000	15	1494.8300	0.2356	46.7692
3228	45-0-0-45	10	1000	15	1494.8300	0.2368	47.3846
3229	45-0-0-45	10	1000	15	1495.7100	0.2346	43.0769
3230	45-0-0-45	10	1000	15	1500.1100	0.2394	38.5641

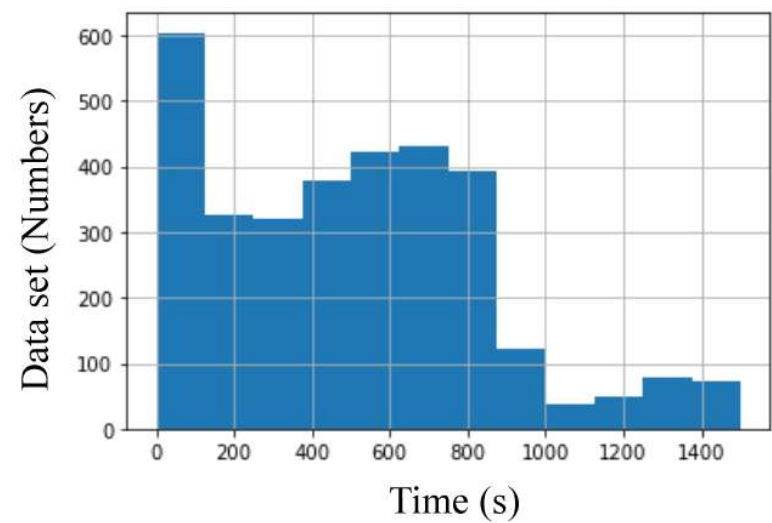
Co-efficient of Friction Prediction Model

Table 2- All data set description parameters for co-efficient of friction model

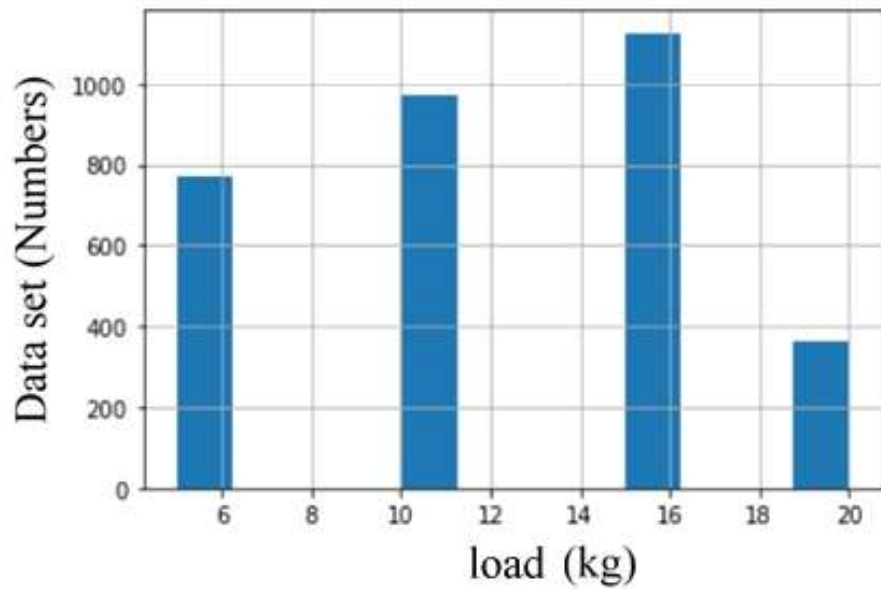
Parameters	Speed of disc	Load	Time	Co-efficient of Friction	Wear
count	3230	3230	3230	3230	3230
mean	778.1734	11.66873	499.9826	0.300914	12.605901
std	248.4459	4.80675	354.1417	0.111396	31.767941
min	500	5	0	0.00039	-81.196600
25%	500	10	200.7638	0.239162	-5.7435900
50%	1000	10	495.7925	0.310763	10.871800
75%	1000	15	732.2325	0.391873	32.307700
max	1000	20	1500.11	0.511881	127.635000



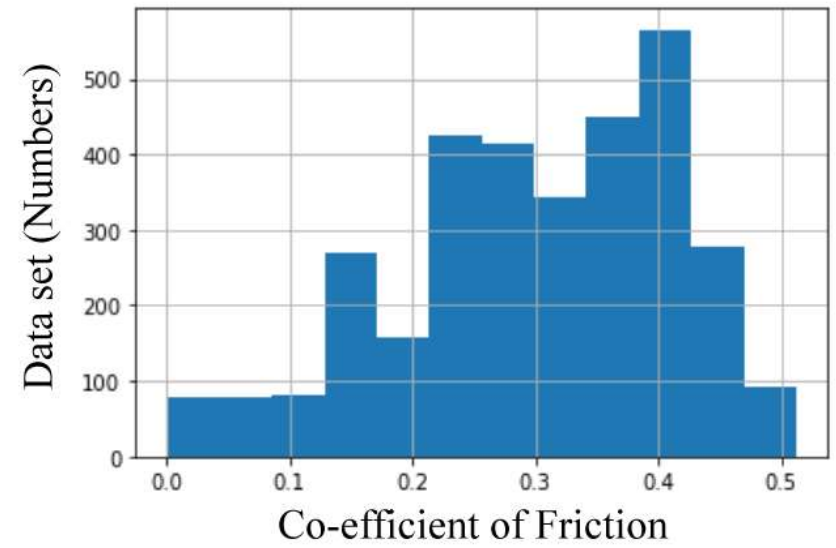
(a)



(b)



(c)



(d)

Fig. Histogram of the data variables (a) Speed of disc, (b) Time, (c) Load and (d) Co-efficient of friction

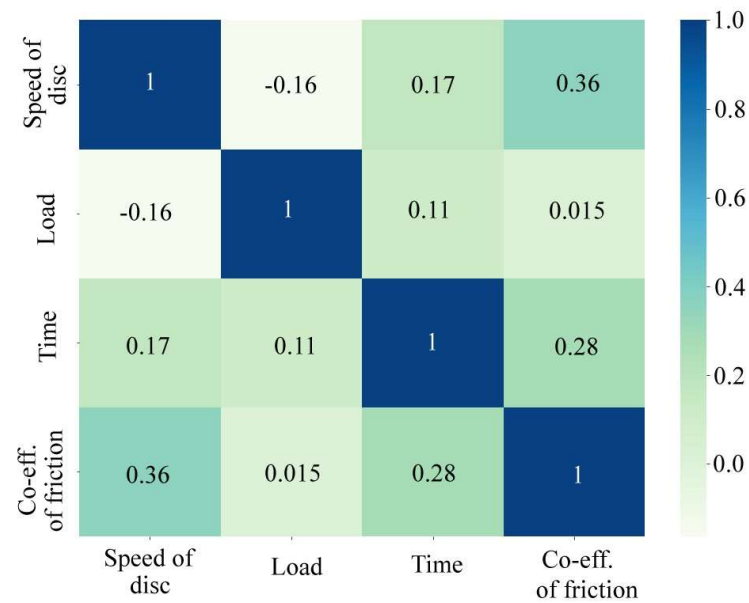


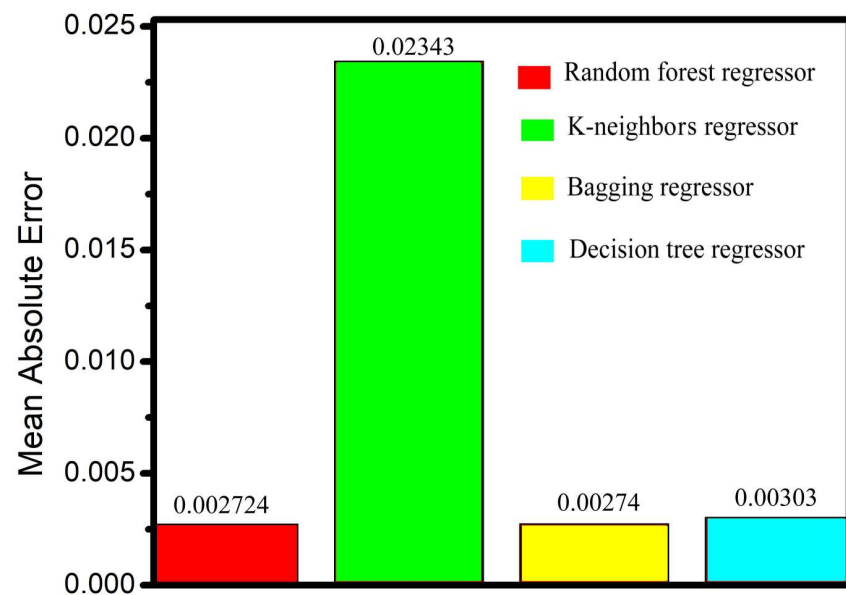
Fig. Correlation matrix for co-efficient of friction prediction model

Table 3- Co-efficient of friction prediction value and percentage errors of all developed ML models

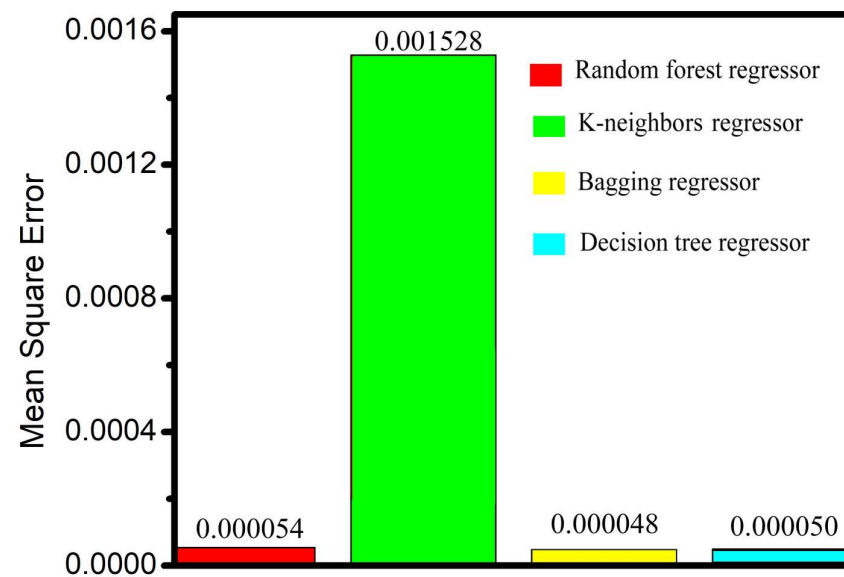
Co-efficient of Friction									
Sr. No	Actual Experiment values (Co-efficient of friction)	Predicted Values				Percentage Error			
		Random Forest Regressor	K neighbors Regressor	Bagging Regressor	Decision Tree Regressor	Random Forest Regressor	K neighbors Regressor	Bagging Regressor	Decision Tree Regressor
1	0.2067	0.2072	0.1999	0.2067	0.20550	0.2413	3.4017	0.0000	0.5835
2	0.4000	0.4017	0.3285	0.4010	0.40163	0.4232	21.7656	0.2494	0.4081
3	0.1719	0.1715	0.2196	0.1717	0.17215	0.2332	21.7213	0.1165	0.1464
4	0.2496	0.2509	0.2498	0.2511	0.25180	0.5181	0.0801	0.5974	0.8749
5	0.3339	0.3389	0.3403	0.3398	0.33782	1.4754	1.8807	1.7363	1.1618
6	0.4147	0.4149	0.3737	0.4154	0.41548	0.0482	10.9714	0.1685	0.1885
7	0.3315	0.3278	0.3270	0.3295	0.32852	1.1287	1.3761	0.6070	0.9057
8	0.1324	0.1329	0.1510	0.1332	0.13317	0.3762	12.3179	0.6006	0.5827
9	0.4892	0.4901	0.4360	0.4910	0.49050	0.1836	12.2018	0.3666	0.2654
10	0.4911	0.4906	0.4534	0.4905	0.49090	0.1019	8.3150	0.1223	0.0395
Average Percentage Error						0.47	9.40	0.46	0.52

Table 4- Error Calculations for Co-efficient of friction prediction models

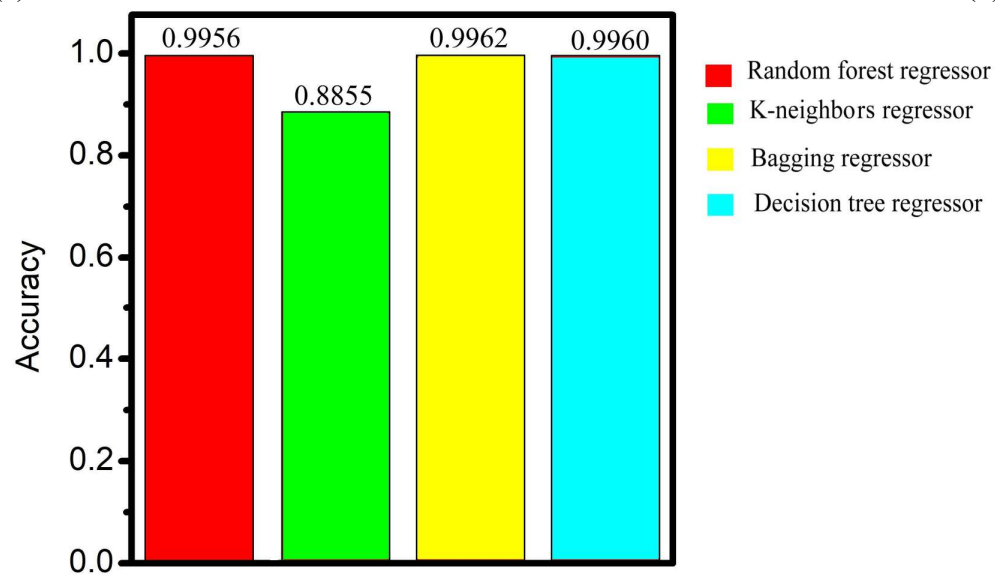
Co efficient of friction	Random Forest Regressor	K-neighbors Regressor	Bagging Regressor	Decision Tree Regressor
MAE	0.002724	0.023430	0.002740	0.003030
MSE	0.000054	0.001528	0.000048	0.000050



(a)



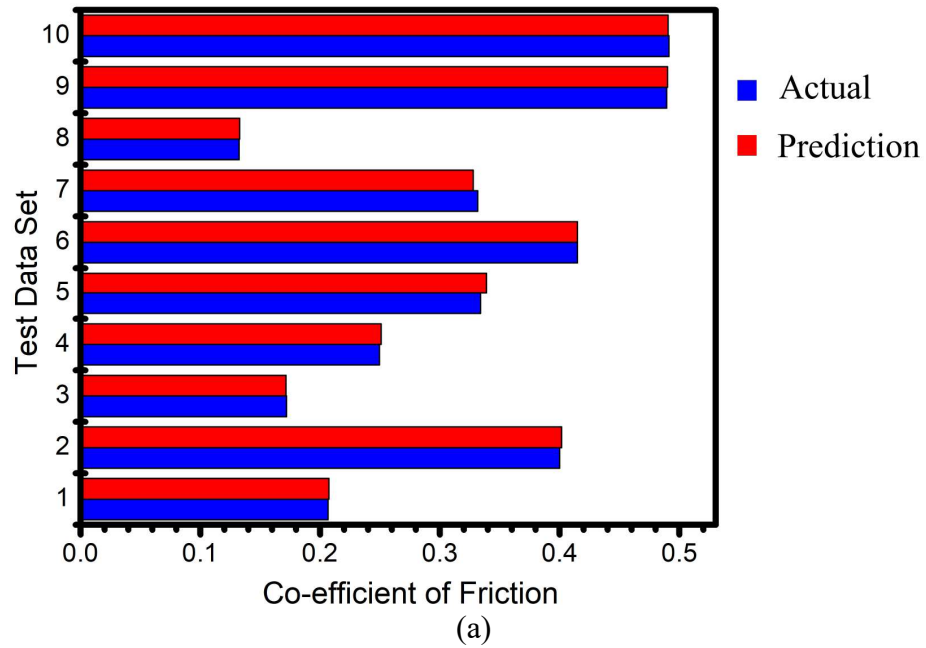
(b)



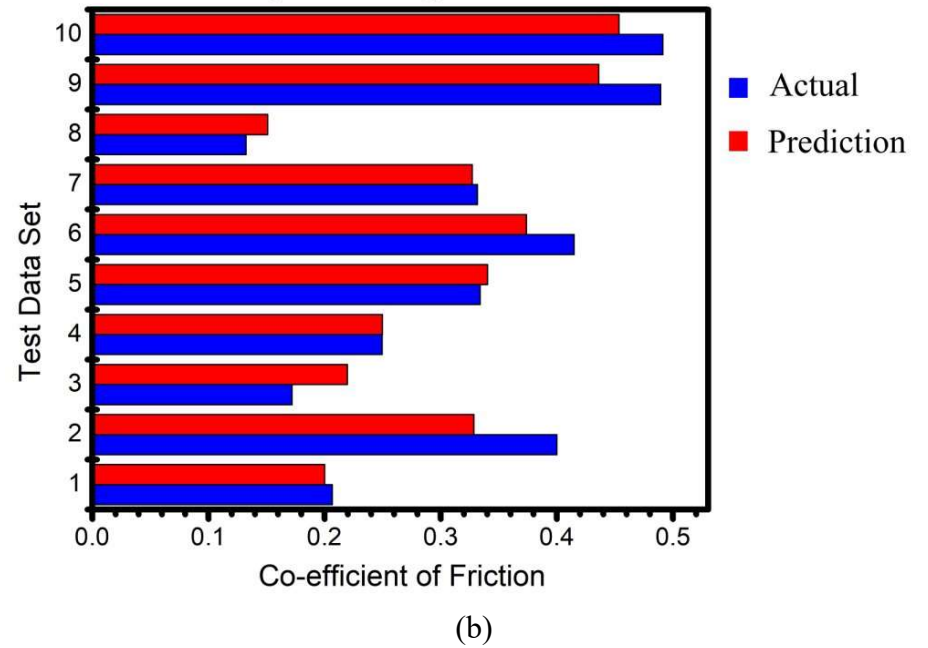
(c)

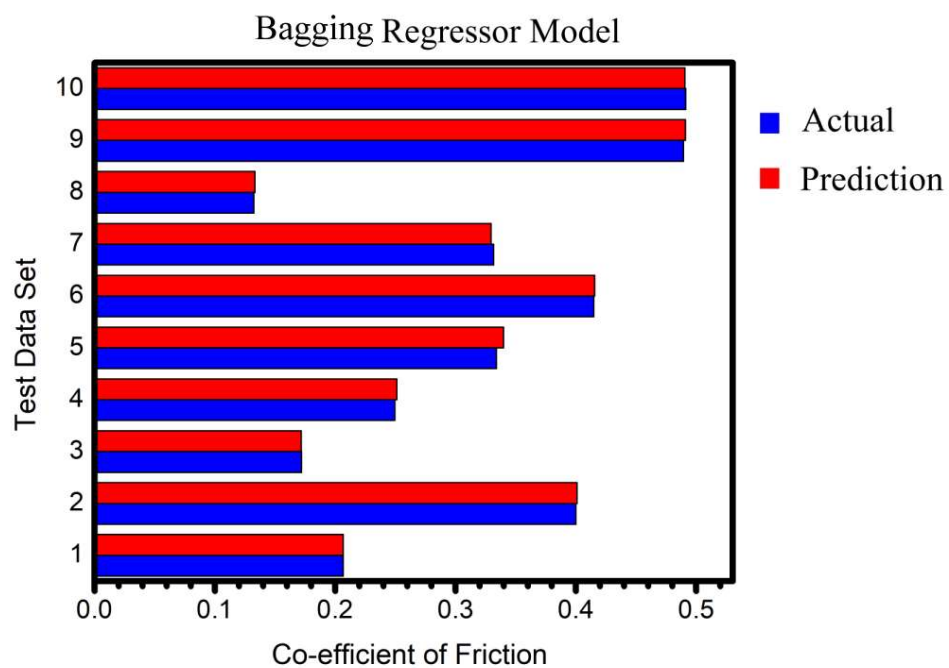
Fig. (a) Mean absolute error, (b) Mean square error and (c) Accuracy

Random Forest Regressor Model

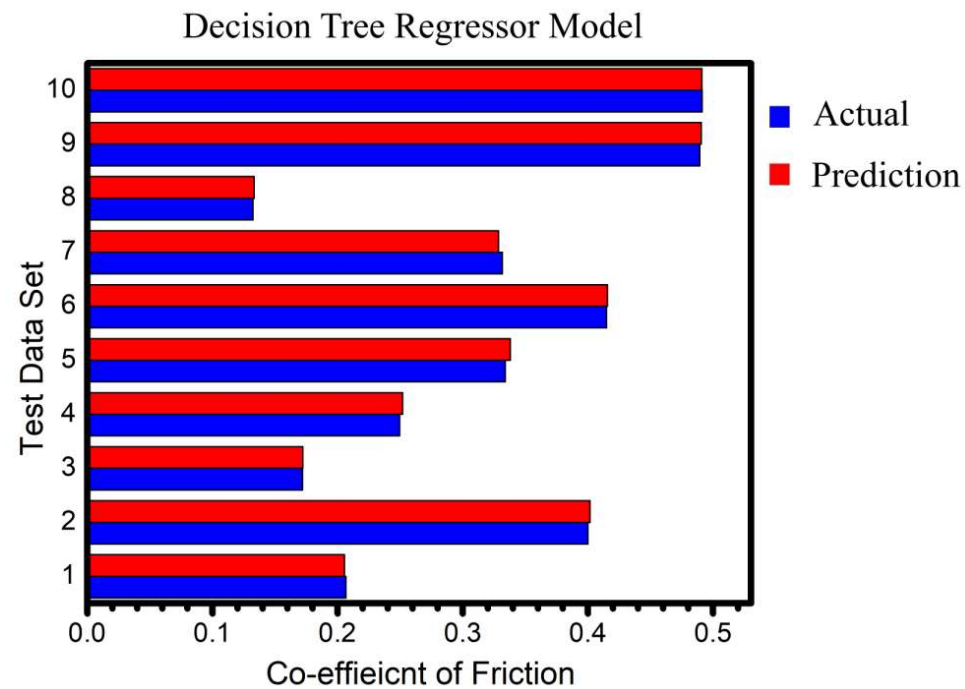


K Neighbors Regressor Model





(c)



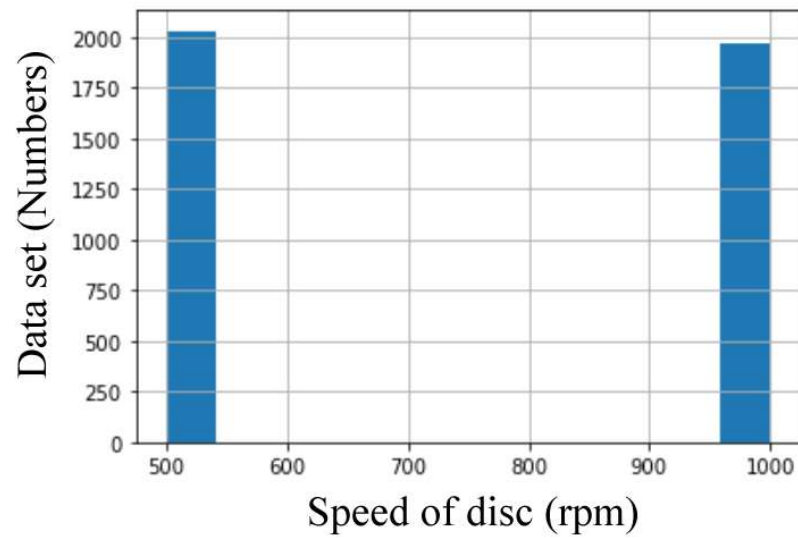
(d)

Fig. Co-efficient of friction prediction models (a) Random forest Regressor, (b) K-Neighbors Regressor, (c) Bagging Regressor and (d) Decision Tree Regressor.

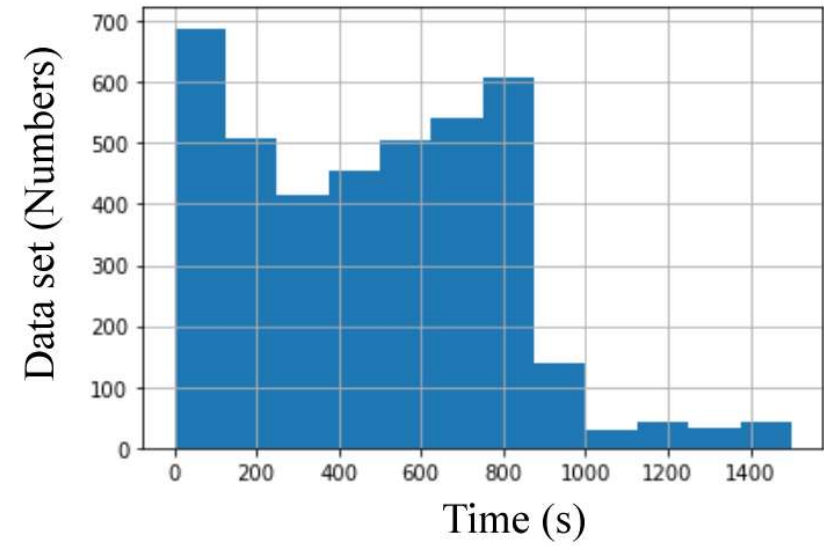
Wear Prediction Model

Table - All data set description parameters for co-efficient of friction model

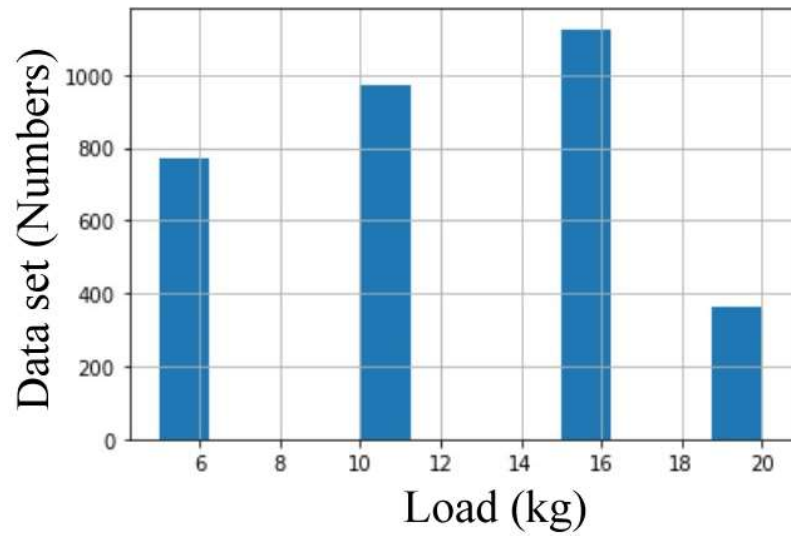
Parameters	Speed of disc	Load	Time	Wear
count	3230	3230	3230	3230
mean	746.3171	11.5193	479.6957	12.605901
std	250.0040	4.7772	316.3673	31.767941
min	500	5	0.0000	-81.196600
25%	500	10	199.5100	-5.7435900
50%	500	10	490.6920	10.871800
75%	1000	15	727.2080	32.307700
max	1000	20	1500.3800	127.635000



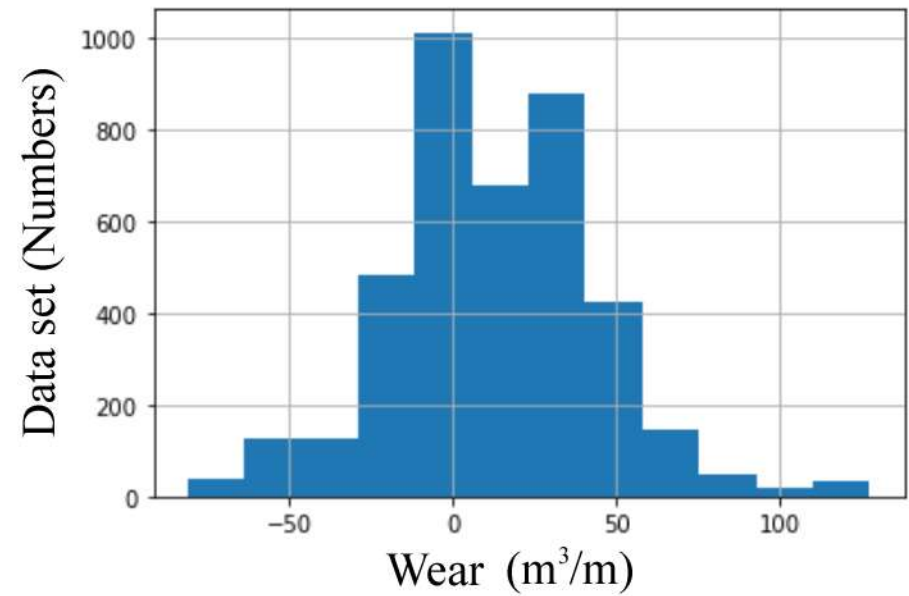
(a)



(b)



(c)



(d)

Fig. Histogram of the data variables (a) Speed of disc, (b) Time, (c) Load and (d) Wear

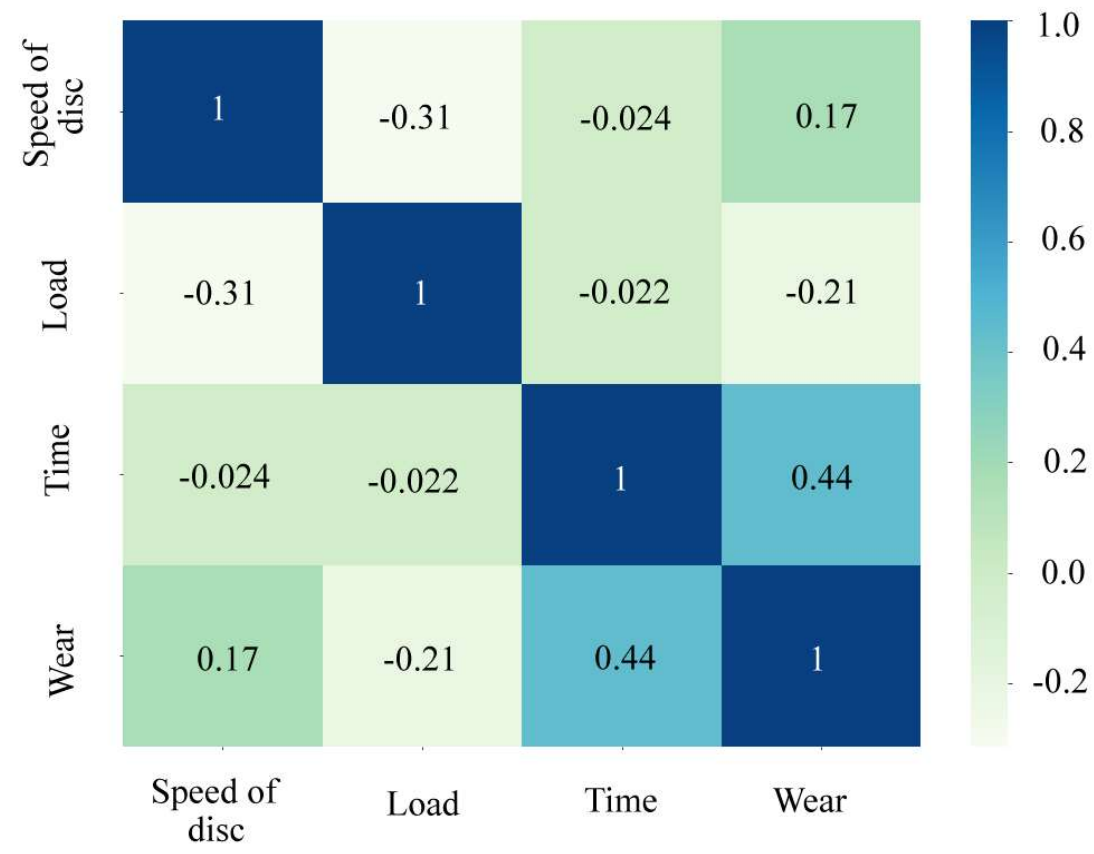


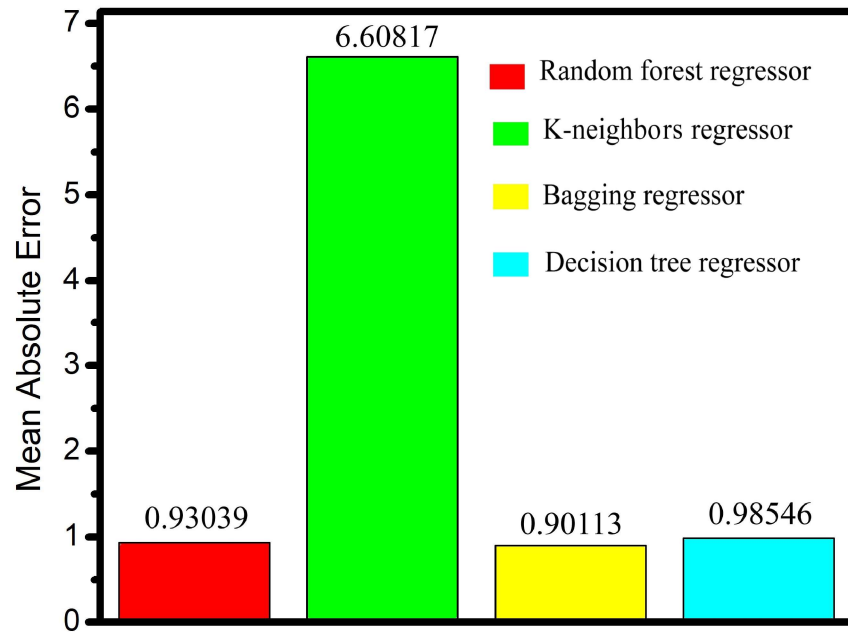
Fig. Correlation matrix for wear prediction model

Table 3- Wear predicted value and percentage errors of all developed ML models

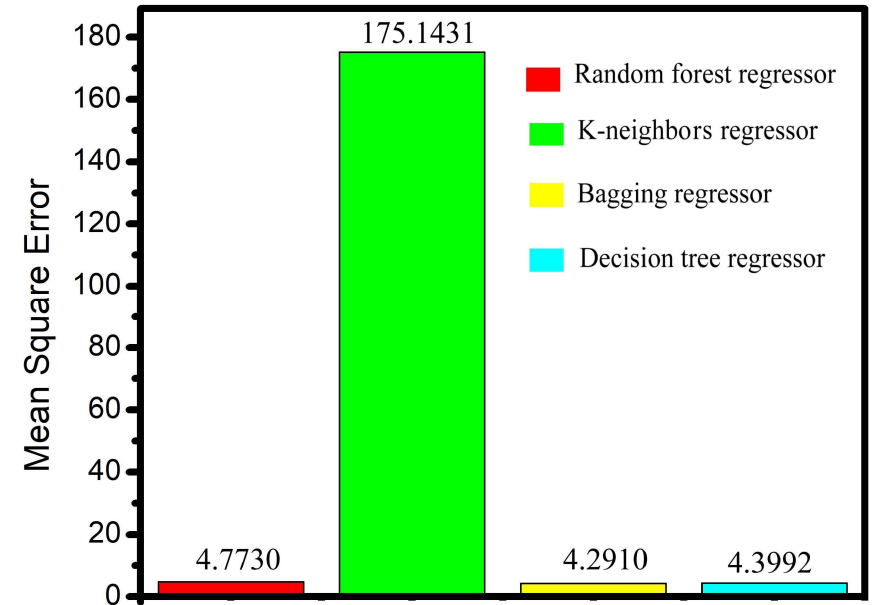
Wear									
Sr. No	Actual Experiment values (Wear)	Predicted Values				Percentage Error			
		Random Forest	K neighbors Regressor	Bagging Regressor	Decision Tree Regressor	Random Forest	K neighbors Regressor	Bagging Regressor	Decision Tree Regressor
1	38.46	39.55	40.59	39.28	38.72	2.75	5.26	2.09	0.66
2	31.17	30.18	30.55	30.31	30.26	3.27	2.01	2.82	3.01
3	-20.80	-20.09	-20.02	-21.43	-20.49	3.50	3.87	2.96	1.49
4	32.21	30.26	35.65	30.94	29.68	6.42	9.67	4.10	8.53
5	23.13	23.62	24.00	23.61	23.50	2.05	3.61	2.01	1.55
6	12.42	12.42	13.20	12.38	12.42	0.01	5.92	0.37	0.00
7	-4.05	-4.09	-4.07	-4.03	-4.06	1.17	0.70	0.32	0.32
8	47.18	48.99	48.38	48.85	49.64	3.71	2.48	3.42	4.96
9	117.66	116.51	92.67	116.72	116.67	0.99	26.98	0.81	0.85
10	48.89	48.79	48.12	48.79	48.89	0.20	1.59	0.20	0.00
Average Percentage Error						2.41	6.21	1.91	2.14

Table 4- Error Calculations for wear prediction models

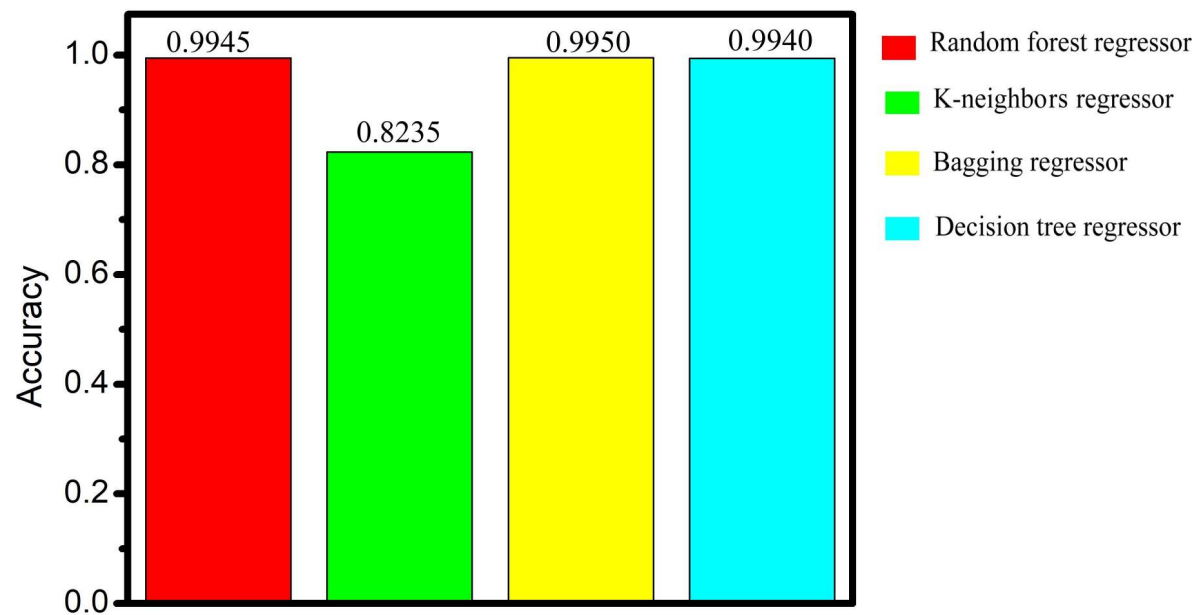
Co efficient of friction	Random Forest Regressor	K-neighbors Regressor	Bagging Regressor	Decision Tree Regressor
MAE	0.930390	6.608173	0.901136	0.985465
MSE	4.773071	175.143114	4.291077	4.399209



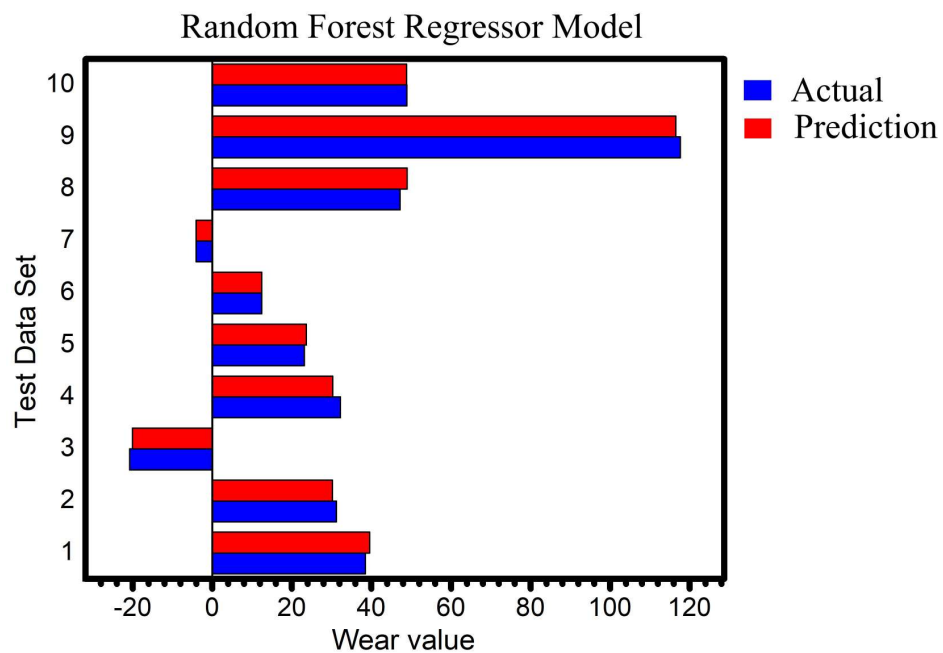
(a)



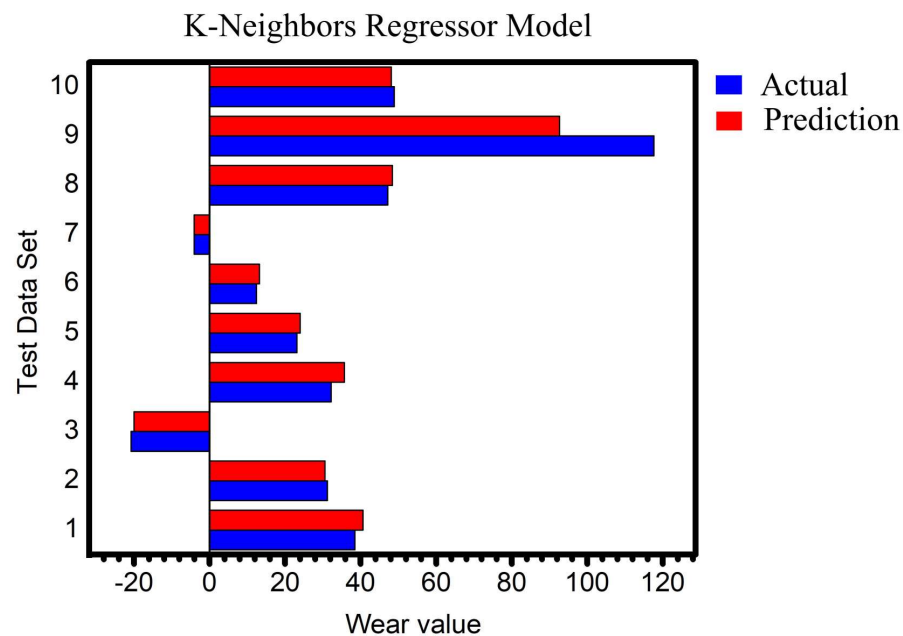
(b)



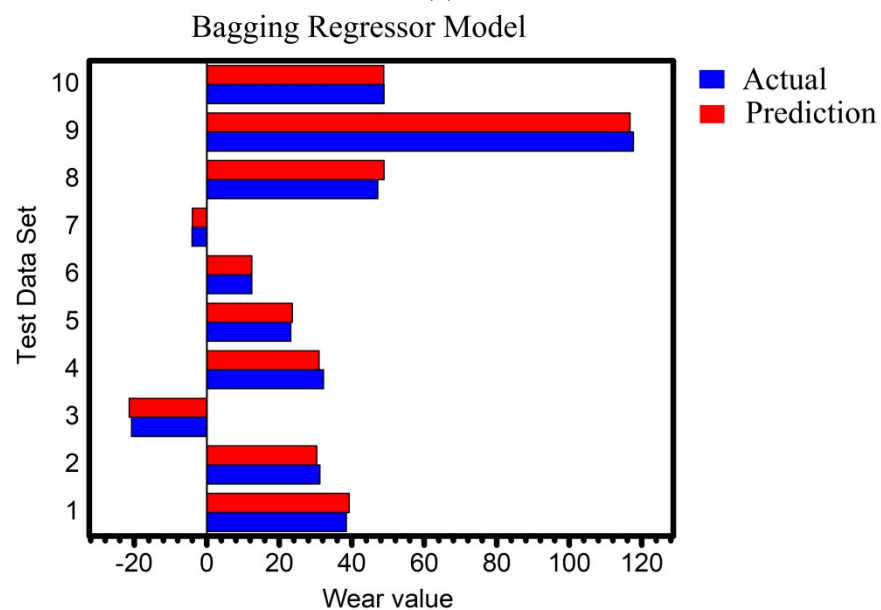
(c)
Fig. (a) Mean absolute error, (b) Mean square error and (c) Accuracy



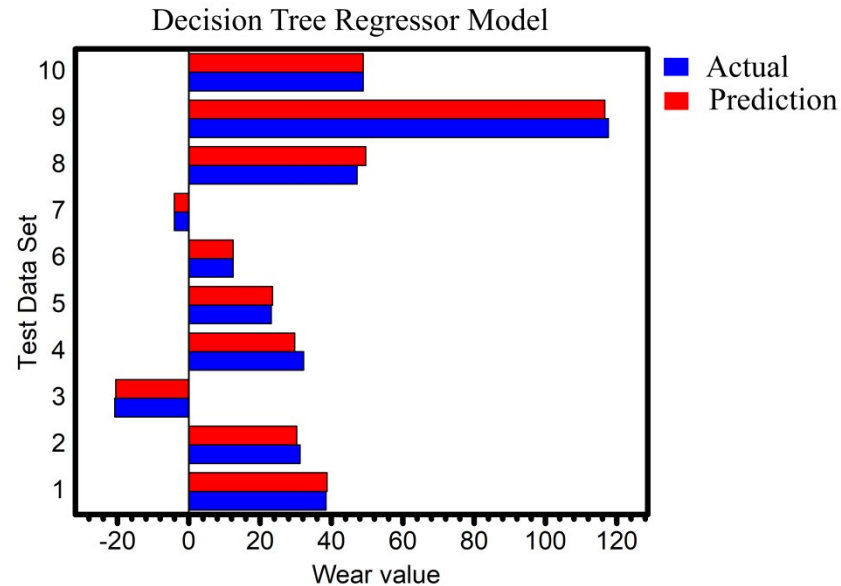
(a)



(b)



(c)



(d)

Fig. Co-efficient of friction prediction models (a) Random forest Regressor, (b) K-Neighbors Regressor, (c) Bagging Regressor and (d) Decision Tree Regressor.