APPENDIX - 2

ANOVA analysis of significant factors of wear rate and coefficient of coating

1. ANOVA for wear rate of coating at 29.9, 44.1, and 58.8 N load and 150, 200 and 250 rpm speed with brass pin.

Use your mouse to right click on individual cells for definitions.
Response 1 MASS LOSS
ANOVA for selected factorial model
Analysis of variance table [Classical sum of squares - Type II]

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob. > F	
Model	5.904E-003	8	7.380E-004	12652.07	< 0.0001	significant
A-LOAD	5.724E-003	2	2.862E-003	49059.80	< 0.0001	
B-SPEED	1.230E-004	2	6.148E-005	1053.97	< 0.0001	
AB	5.769E-005	4	1.442E-005	247.26	< 0.0001	
Pure Error	5.250E-007	9	5.833E-008			
Cor Total	5.905E-003	17				

The Model F-value of 12652.07 implies the model is significant. There is onlya 0.01% chance that a "Model F-Value" this large could occur due to noise.

Values of "Prob. > F" less than 0.0500 indicate model terms are significant.
In this case A, B, AB are significant model terms.
Values greater than 0.1000 indicate the model terms are not significant.
If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model.

Std. Dev.	2.415E-004	R-Squared	0.9999
Mean	0.024	Adj. R-Squared	0.9998
C.V. %	1.02	Pred. R-Squared	0.9996
PRESS	2.100E-006	Adeq. Precision	288.671

The "Pred R-Squared" of 0.9996 is in reasonable agreement with the "Adj R-Squared" of 0.9998.

"Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Your
ratio of 288.671 indicates an adequate signal. This model can be used to navigate the design space.

Term	Coefficient Estimate	df	Standard Error	95% CI Low	95% CI High
Intercept	0.024	1	5.693E-005	0.024	0.024
A[1]	2.514E-004	1	8.041E-007	2.496E-004	2.532E-004
A[2]	-7.868E-004	1	3.956E-005	-8.763E-004	-6.974E-004
B[1]	3.108E-003	1	6.972E-005	2.951E-003	3.266E-003
B[2]	4.417E-004	1	4.025E-005	3.506E-004	5.327E-004
A[1]B[1]	2.801E-005	1	9.849E-007	2.578E-005	3.024E-005
A[2]B[1]	-5.256E-004	1	4.845E-005	-6.352E-004	-4.160E-004
A[1]B[2]	2.897E-006	1	5.686E-007	1.611E-006	4.183E-006
A[2]B[2]	-1.693E-004	1	2.797E-005	-2.326E-004	-1.060E-004

APPENDIX - 2

```
 Final Equation in Terms of Coded Factors:

MASS LOSS    =
+0.024
+2.514E-004  * A [1]
-7.868E-004  * A [2]
+3.108E-003  * B [1]
+4.417E-004  * B [2]
+2.801E-005  * A [1] B [1]
-5.256E-004  * A [2] B [1]
+2.897E-006  * A [1] B [2]
-1.693E-004  * A [2] B [2]
```

2. ANNOVA for wear rate of coating at 29.9, 44.1, and 58.8 N load and 150, 200 and 250 rpm speed with medium carbon steel pin.

Use your mouse to right click on individual cells for definitions.
Response 1 MASS LOSS
ANOVA for selected factorial model
Analysis of variance table [Classical sum of squares - Type II]

Source	Sum of Squares	DF	Mean Square	F Value	p-value Prob. > F	
Model	5.354E-003	8	6.692E-004	974.55	< 0.0001	significant
A-LOAD	2.905E-003	2	1.453E-003	2115.47	< 0.0001	
B-SPEED	1.717E-003	2	8.586E-004	1250.40	< 0.0001	
AB	7.311E-004	4	1.828E-004	266.17	< 0.0001	
Pure Error	6.180E-006	9	6.867E-007			
Cor Total	5.360E-003	17				

The Model F-value of 974.55 implies the model is significant. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise.

Values of "Prob > F" less than 0.0500 indicate model terms are significant.
In this case A, B, AB are significant model terms.
Values greater than 0.1000 indicate the model terms are not significant.
If there are many insignificant model terms (not counting those required to support hierarchy),
model reduction may improve your model.

Std. Dev.	8.287E-004	R-Squared	0.9988
Mean	0.059	Adj R-Squared	0.9978
C.V. %	1.41	Pred R-Squared	0.9954
PRESS	2.472E-005	Adeq Precision	103.934

The "Pred R-Squared" of 0.9954 is in reasonable agreement with the "Adj R-Squared" of 0.9978.

"Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Your
ratio of 103.934 indicates an adequate signal. This model can be used to navigate the design space.

Term	Coefficient Estimate	df	Standard Error	95% CI Low	95% CI High
Intercept	0.059 1	1	1.953E-004	0.058	0.059
A[1]	1.794E-004	1	2.759E-006	1.732E-004	1.856E-004
A[2]	2.230E-004	1	1.357E-004	-8.396E-005	5.300E-004
B[1]	0.012	1	2.392E-004	0.011	0.012
B[2]	1.483E-003	1	1.381E-004	1.171E-003	1.796E-003
A[1]B[1]	9.959E-005	1	3.379E-006	9.194E-005	1.072E-004
A[2]B[1]	1.933E-003	1	1.662E-004	1.557E-003	2.309E-003
A[1]B[2]	1.390E-005	1	1.951E-006	9.489E-006	1.832E-005
A[2]B[2]	3.044E-004	1	9.596E-005	8.727E-005	5.214E-004

APPENDIX - 2

```
 Final Equation in Terms of Coded Factors:

MASS LOSS    =
+0.059
+1.794E-004  * A[1]
+2.230E-004  * A[2]
+0.012       * B[1]
+1.483E-003  * B[2]
+9.959E-005  * A[1]B[1]
+1.933E-003  * A[2]B[1]
+1.390E-005  * A[1]B[2]
+3.044E-004  * A[2]B[2]
```

3. ANNOVA for wear rate of coating at 29.9, 44.1, and 58.8 N load and 150, 200 and 250 rpm speed with high carbon steel pin.

Use your mouse to right click on individual cells for definitions.
Response 1 MASS LOSS
ANOVA for selected factorial model
Analysis of variance table [Classical sum of squares - Type II]

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob. > F	
Model	7.107E-003	8	8.883E-004	1256.08	< 0.0001	significant
A-LOAD	2.441E-003	2	1.220E-003	1725.55	< 0.0001	
B-SPEED	4.498E-003	2	2.249E-003	3180.19	< 0.0001	
AB	1.677E-004	4	4.193E-005	59.29	< 0.0001	
Pure Error	6.365E-006	9	7.072E-007			
Cor Total	7.113E-003	17				

The Model F-value of 1256.08 implies the model is significant. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise.

Values of "Prob > F" less than 0.0500 indicate model terms are significant.
In this case A, B, AB are significant model terms.
Values greater than 0.1000 indicate the model terms are not significant.
If there are many insignificant model terms (not counting those required to support hierarchy),
model reduction may improve your model.

Std. Dev. 8.410E-004 R-Squared 0.9991
Mean 0.065 Adj R-Squared 0.9983
C.V. % 1.30 Pred R-Squared 0.9964
PRESS 2.546E-005 Adeq Precision 117.211

The "Pred R-Squared" of 0.9964 is in reasonable agreement with the "Adj R-Squared" of 0.9983.

"Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Your
ratio of 117.211 indicates an adequate signal. This model can be used to navigate the design space.

Term	Coefficient Estimate	df	Standard Error	95% CI Low	95% CI High
Intercept	0.065	1	1.982E-004	0.064	0.065
A[1]	1.638E-004	1	2.800E-006	1.575E-004	1.702E-004
A[2]	7.193E-004	1	1.377E-004	4.077E-004	1.031E-003
B[1]	0.019	1	2.428E-004	0.018	0.019
B[2]	-3.153E-003	1	1.402E-004	-3.470E-003	-2.836E-003
A[1]B[1]	2.970E-005	1	3.429E-006	2.194E-005	3.746E-005
A[2]B[1]	2.135E-003	1	1.687E-004	1.753E-003	2.517E-003
A[1]B[2]	-1.177E-006	1	1.980E-006	-5.655E-006	3.302E-006
A[2]B[2]	1.221E-004	1	9.739E-005	-9.826E-005	3.424E-004

APPENDIX - 2

```
Final Equation in Terms of Coded Factors:

MASS LOSS    =
+0.065
+1.638E-004  * A[1]
+7.193E-004  * A[2]
+0.019       * B[1]
-3.153E-003  * B[2]
+2.970E-005  * A[1]B[1]
+2.135E-003  * A[2]B[1]
-1.177E-006  * A[1]B[2]
+1.221E-004  * A[2]B[2]
```

4. ANOVA for coefficient of friction of coating at 29.9, 44.1, and 58.8 N load and 150, 200 and 250 rpm speed with brass pin.

```
       Use your mouse to right click on individual cells for definitions.
Response    2     FRICTION
        ANOVA for selected factorial model
Analysis of variance table [Classical sum of squares - Type II]
```

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob. > F	
Model	0.14	8	0.017	128.14	< 0.0001	significant
A-LOAD	0.022	2	0.011	84.60	< 0.0001	
B-SPEED	0.11	2	0.053	399.89	< 0.0001	
AB	7.392E-003	4	1.848E-003	14.03	0.0007	
Pure Error	1.186E-003	9	1.317E-004			
Cor Total	0.14	17				

The Model F-value of 128.14 implies the model is significant. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise.

Values of "Prob > F" less than 0.0500 indicate model terms are significant.
In this case A, B, AB are significant model terms.
Values greater than 0.1000 indicate the model terms are not significant.
If there are many insignificant model terms (not counting those required to support hierarchy),
model reduction may improve your model.

Std. Dev.	0.011	R-Squared	0.9913
Mean	0.74	Adj R-Squared	0.9836
C.V. %	1.55	Pred R-Squared	0.9652
PRESS	4.743E-003	Adeq Precision	31.147

The "Pred R-Squared" of 0.9652 is in reasonable agreement with the "Adj R-Squared" of 0.9836.

"Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Your
ratio of 31.147 indicates an adequate signal. This model can be used to navigate the design space.

Term	Coefficient Estimate	df	Standard Error	95% CI Low	95% CI High
Intercept	0.74	1	2.705E-003	0.73	0.75
A[1]	-4.945E-004	1	3.822E-005	-5.809E-004	-4.080E-004
A[2]	2.498E-003	1	1.880E-003	-1.755E-003	6.750E-003
B[1]	-0.092	1	3.313E-003	-0.099	-0.084
B[2]	0.012	1	1.913E-003	7.300E-003	0.016
A[1]B[1]	-1.411E-005	1	4.680E-005	-1.200E-004	9.177E-005
A[2]B[1]	0.017	1	2.302E-003	0.012	0.022
A[1]B[2]	8.373E-006	1	2.702E-005	-5.276E-005	6.950E-005
A[2]B[2]	-8.913E-004	1	1.329E-003	-3.898E-003	2.116E-003

```
Final Equation in Terms of Coded Factors:

FRICTION     =
+0.74
-4.945E-004  * A[1]
+2.498E-003  * A[2]
-0.092       * B[1]
+0.012       * B[2]
-1.411E-005  * A[1]B[1]
+0.017       * A[2]B[1]
+8.373E-006  * A[1]B[2]
-8.913E-004  * A[2]B[2]
```

5. ANOVA for coefficient of friction of coating at 29.9, 44.1, and 58.8 N load and 150, 200 and 250 rpm speed with medium carbon steel pin.

Use your mouse to right click on individual cells for definitions.
Response 2 FRICTION
ANOVA for selected factorial model
Analysis of variance table [Classical sum of squares - Type II]

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob. > F	
Model	0.042	8	5.290E-003	1023.37	< 0.0001	significant
A-LOAD	0.020	2	9.949E-003	1924.57	< 0.0001	
B-SPEED	0.017	2	8.596E-003	1662.80	< 0.0001	
AB	5.233E-003	4	1.308E-003	253.06	< 0.0001	
Pure Error	4.652E-005	9	5.169E-006			
Cor Total	0.042 17					

The Model F-value of 1023.37 implies the model is significant. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise.

Values of "Prob > F" less than 0.0500 indicate model terms are significant.
In this case A, B, AB are significant model terms.
Values greater than 0.1000 indicate the model terms are not significant.
If there are many insignificant model terms (not counting those required to support hierarchy),
model reduction may improve your model.

Std. Dev.	2.274E-003	R-Squared	0.9989
Mean	0.75	Adj R-Squared	0.9979
C.V. %	0.30	Pred R-Squared	0.9956
PRESS	1.861E-004	Adeq Precision	116.688

The "Pred R-Squared" of 0.9956 is in reasonable agreement with the "Adj R-Squared" of 0.9979.

"Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Your
ratio of 116.688 indicates an adequate signal. This model can be used to navigate the design space.

Term	Coefficient Estimate	df	Standard Error	95% CI Low	95% CI High
Intercept	0.75	1	5.359E-004	0.75	0.75
A[1]	-4.667E-004	1	7.570E-006	-4.838E-004	-4.496E-004
A[2]	-2.588E-003	1	3.724E-004	-3.430E-003	-1.745E-003
B[1]	-0.038	1	6.563E-004	-0.039	-0.036
B[2]	-3.333E-005	1	3.789E-004	-8.906E-004	8.239E-004
A[1]B[1]	1.908E-004	1	9.271E-006	1.698E-004	2.117E-004
A[2]B[1]	-6.334E-003	1	4.561E-004	-7.366E-003	-5.302E-003
A[1]B[2]	-1.058E-004	1	5.353E-006	-1.179E-004	-9.369E-005
A[2]B[2]	6.088E-004	1	2.633E-004	1.322E-005	1.204E-003

APPENDIX - 2

Final Equation in Terms of Coded Factors:

```
FRICTION     =
+0.75
-4.667E-004  * A[1]
-2.588E-003  * A[2]
-0.038       * B[1]
-3.333E-005  * B[2]
+1.908E-004  * A[1]B[1]
-6.334E-003  * A[2]B[1]
-1.058E-004  * A[1]B[2]
+6.088E-004  * A[2]B[2]
```

6. ANOVA for coefficient of friction of coating at 29.9, 44.1, and 58.8 N load and 150, 200 and 250 rpm speed with medium carbon steel pin.

Use your mouse to right click on individual cells for definitions.
Response 2 FRICTION
ANOVA for selected factorial model
Analysis of variance table [Classical sum of squares - Type II]

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob. > F	
Model	0.12	8	0.015	2033.80	< 0.0001	significant
A-LOAD	0.042	2	0.021	2783.63	< 0.0001	
B-SPEED	0.077	2	0.038	5088.73	< 0.0001	
AB	3.975E-003	4	9.938E-004	131.42	< 0.0001	
Pure Error	6.806E-005	9	7.562E-006			
Cor Total	0.12	17				

The Model F-value of 2033.80 implies the model is significant. There is only a 0.01% chance that a "Model F-Value" this large could occur due to noise.

Values of "Prob. > F" less than 0.0500 indicate model terms are significant.
In this case A, B, AB are significant model terms.
Values greater than 0.1000 indicate the model terms are not significant.
If there are many insignificant model terms (not counting those required to support hierarchy),
model reduction may improve your model.

Std. Dev.	2.750E-003	R-Squared	0.9994
Mean	0.81	Adj R-Squared	0.9990
C.V. %	0.34	Pred R-Squared	0.9978
PRESS	2.722E-004	Adeq Precision	159.886

The "Pred R-Squared" of 0.9978 is in reasonable agreement with the "Adj R-Squared" of 0.9990.

"Adeq Precision" measures the signal to noise ratio. A ratio greater than 4 is desirable. Your
ratio of 159.886 indicates an adequate signal. This model can be used to navigate the design space.

Term	Coefficient Estimate	df	Standard Error	95% CI Low	95% CI High
Intercept	0.81	1	6.482E-004	0.81	0.81
A[1]	-6.810E-004	1	9.156E-006	-7.018E-004	-6.603E-004
A[2]	-2.635E-003	1	4.504E-004	-3.654E-003	-1.616E-003
B[1]	-0.080	1	7.938E-004	-0.081	-0.078
B[2]	4.628E-003	1	4.583E-004	3.591E-003	5.665E-003
A[1]B[1]	-5.409E-005	1	1.121E-005	-7.945E-005	-2.872E-005
A[2]B[1]	-6.500E-003	1	5.516E-004	-7.748E-003	-5.252E-003
A[1]B[2]	-1.172E-004	1	6.474E-006	-1.318E-004	-1.025E-004
A[2]B[2]	-1.911E-003	1	3.185E-004	-2.631E-003	-1.190E-003

```
Final Equation in Terms of Coded Factors:

FRICTION     =
+0.81
-6.810E-004  * A[1]
-2.635E-003  * A[2]
-0.080       * B[1]
+4.628E-003  * B[2]
-5.409E-005  * A[1]B[1]
-6.500E-003  * A[2]B[1]
-1.172E-004  * A[1]B[2]
-1.911E-003  * A[2]B[2]
```

The Diagnostics Case Statistics Report has been moved to the Diagnostics Node.
In the Diagnostics Node, Select Case Statistics from the View Menu.

Proceed to Diagnostic Plots (the next icon in progression). Be sure to look at the:

1) Normal probability plot of the studentized residuals to check for normality of residuals.
2) Studentized residuals versus predicted values to check for constant error.
3) Externally Studentized Residuals to look for outliers, i.e., influential values.
4) Box-Cox plot for power transformations.

If all the model statistics and diagnostic plots are OK, finish up with the Model Graphs icon.

APPENDIX - 2

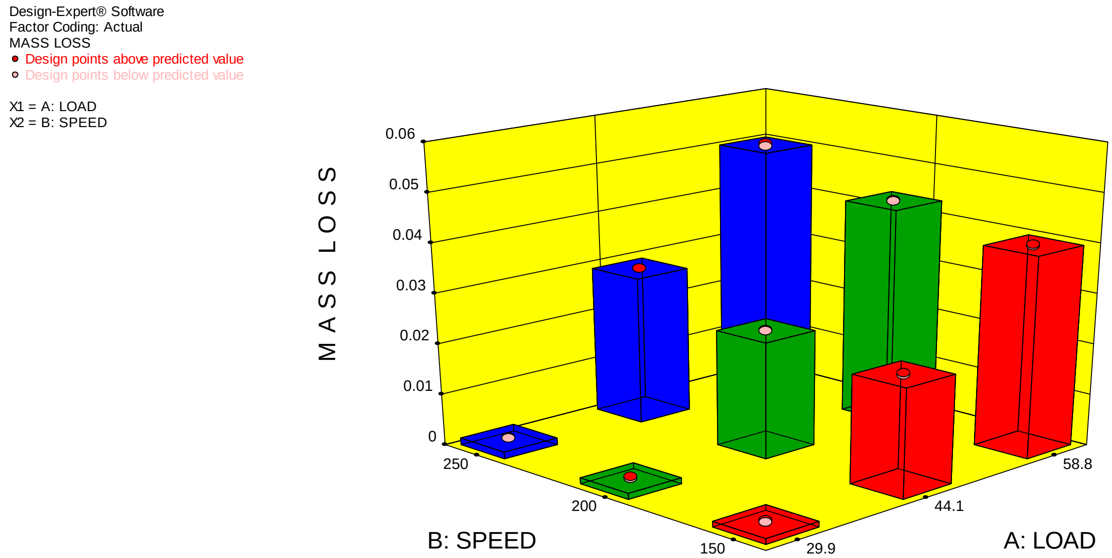

Figure 1. Three-Dimensional graph of wear rate of coating with brass pin at various loading and sliding conditions

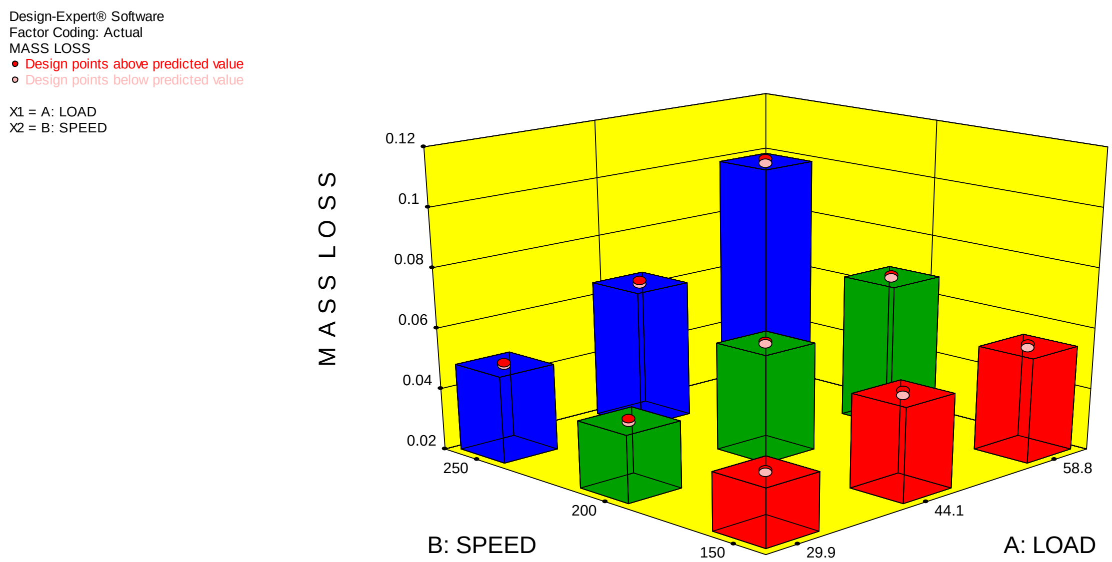

Figure 2. Three-Dimensional graph of wear rate of coating with medium carbon steel pin at various loading and sliding conditions

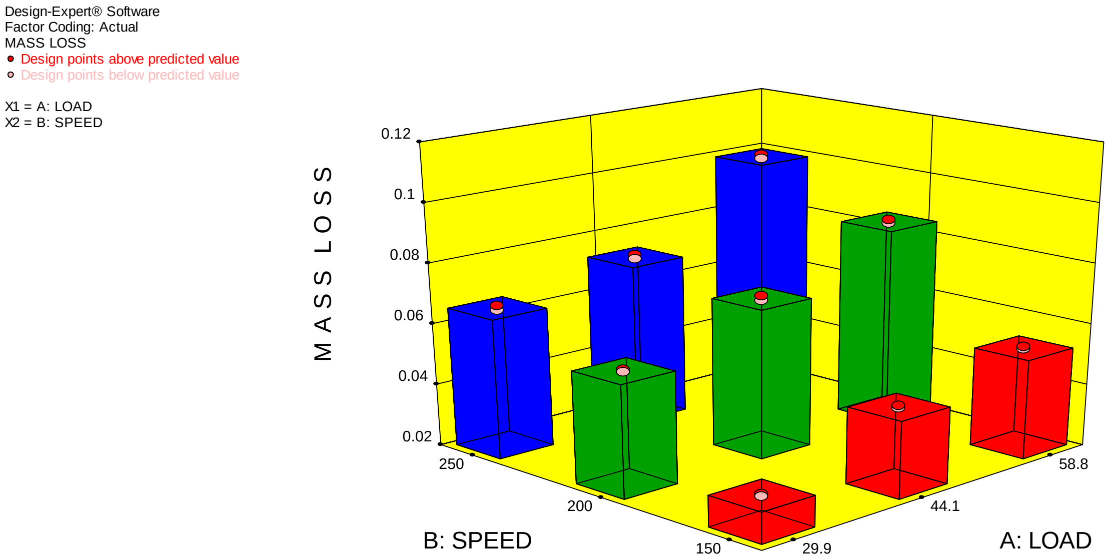

Figure 3. Three-Dimensional graph of wear rate of coating with high carbon steel pin at various loading and sliding conditions

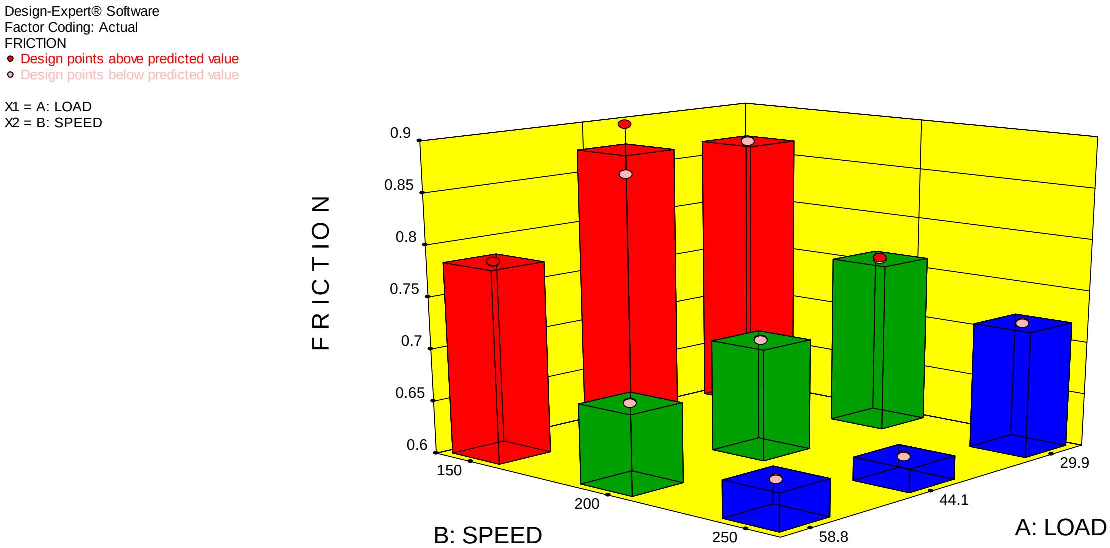

Figure 4. Three-Dimensional graph of co-efficient of friction of coating with brass pin at various loading and sliding conditions

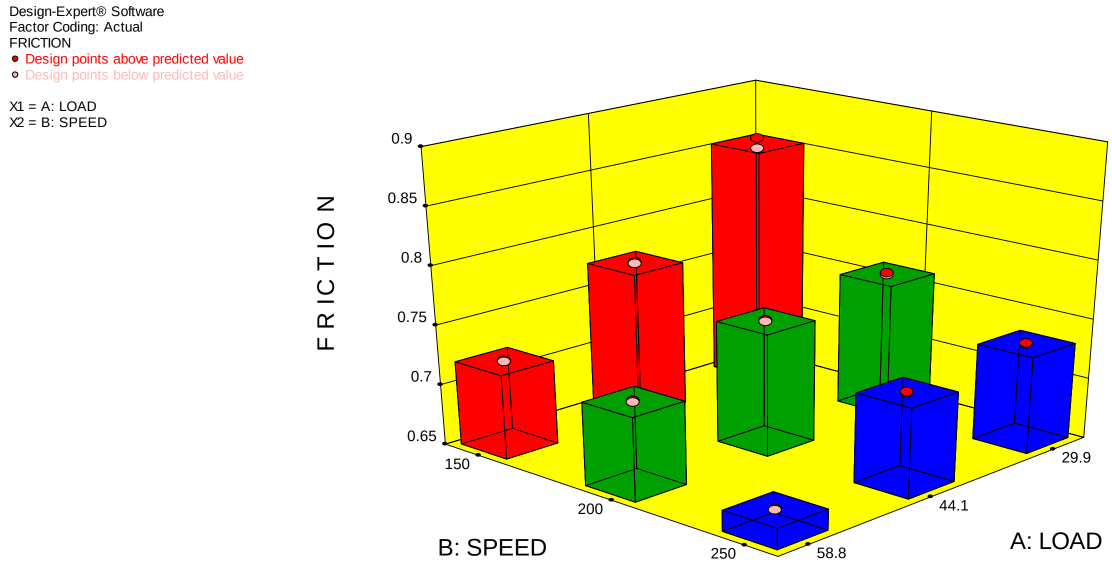

Figure 5. Three-Dimensional graph of co-efficient of friction of coating with medium carbon steel at various loading and sliding conditions

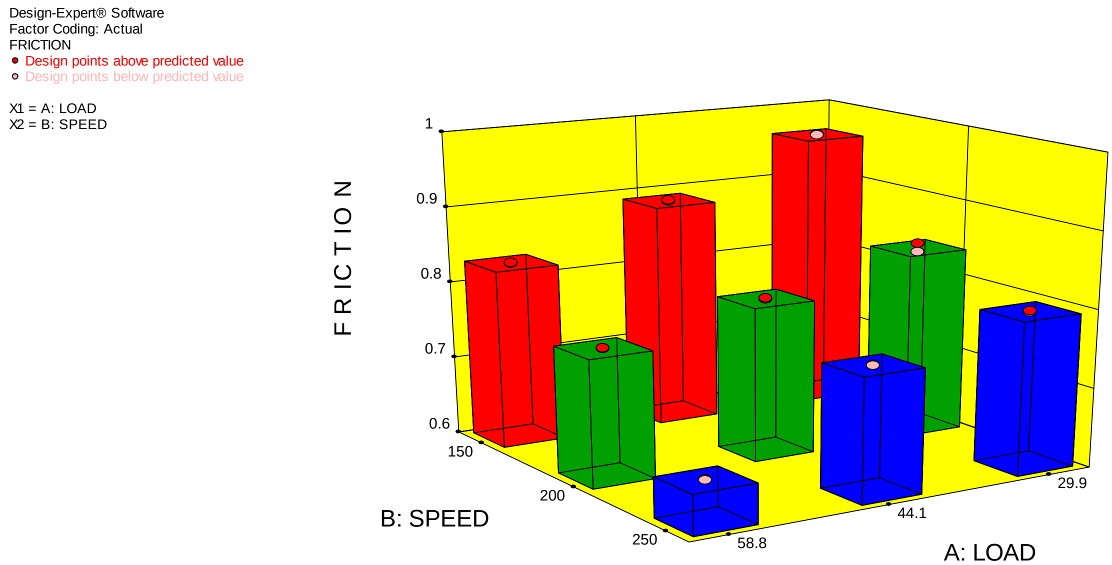

Figure 6. Three-Dimensional graph of co-efficient of friction of coating with high carbon steel at various loading and sliding conditions