

Appendix 8

ANOVA – Impact Characteristics

Variance Due to Varying Drop Height

For each characteristic, ANOVA was performed using a 0.05 (5%) level of significance, i.e. if the p -value obtained was less than 0.05, there would be a significant level of variance.

1.1 Maximum Force

H_0 : There is no difference between the maximum forces produced as drop height is varied.

H_a : There is a difference between the maximum forces produced as drop height is varied.

Dataset Used For Calculation:

	Drop Height		
	5 cm	4 cm	3cm
Peak Force	175.21	141.59	177.59
	201.70	177.74	216.72
	265.67	193.81	164.95
	234.28	163.16	219.85
	190.09	231.01	-
Average	213.39	181.46	194.78
SD	36.42	30.15	23.95

Results:

Anova: Single Factor						
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
5 cm	5	1066.95	213.39	1326.712		
4 cm	5	907.31	181.462	1136.518		
3 cm	4	779.11	194.7775	765.0645		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	2568.535	2	1284.267	1.162892	0.348217	3.98229
Within Groups	12148.11	11	1104.374			8
Total	14716.65	13				

Conclusion:

As the $p > 0.05$, H_0 is accepted and H_a rejected. Therefore there is no significant difference between the maximum forces as drop height is varied.

1.2 Peak Pressure

H_0 : There is no difference between the peak pressures produced as drop height is varied.

H_a : There is a difference between the peak pressures produced as drop height is varied.

Dataset Used For Calculation:

	Drop Height		
	5 cm	4 cm	3cm
Peak Pressure	557.72	450.69	565.29
	642.02	565.77	689.85
	845.66	616.92	525.04
	745.73	519.36	699.79
	605.08	735.31	-
Average	679.242	577.61	619.99
SD	115.94	95.98	76.25

Results:

Anova: Single Factor						
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
5 cm	5	3396.21	679.242	13442.17		
4 cm	5	2888.05	577.61	11514.13		
3 cm	4	2479.97	619.9925	7752.017		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	26025.87	2	13012.93	1.16299	0.348188	3.982298
Within Groups	123081.2	11	11189.2			
Total	149107.1	13				

Conclusion:

As the $p > 0.05$, H_0 is accepted and H_a rejected. Therefore there is no significant difference between the peak pressures as drop height is varied.

1.3 Time to Maximum Force From Point of Contact

H_0 : There is no difference between the time to maximum force as drop height is varied.

H_a : There is a difference between the time to maximum force as drop height is varied.

Dataset Used For Calculation:

	Drop Height		
	5 cm	4 cm	3cm
Time to Maximum Force From Point of Contact	0.045	0.061	0.057
	0.055	0.061	0.037
	0.041	0.049	0.031
	0.031	0.053	0.039
	0.051	0.035	-
Average	0.045	0.050	0.041
SD	0.01	0.01	-0.01

Results:

Anova: Single Factor						
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
5 cm	5	0.223	0.0446	8.68E-05		
4 cm	5	0.259	0.0518	0.000115		
3 cm	4	0.164	0.041	0.000125		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	0.000278	2	0.000139	1.290058	0.313827	3.982298
Within Groups	0.001184	11	0.000108			
Total	0.001462	13				

Conclusion:

As the $p > 0.05$, H_0 is accepted and H_a rejected. Therefore there is no significant difference between the times taken to reach maximum force as drop height is varied.

1.4 Skin Displacement

H_0 : There is no difference between the level of skin displacement as drop height is varied.

H_a : There is a difference between the skin displacement as drop height is varied.

Dataset Used For Calculation:

	Drop Height		
	5 cm	4 cm	3cm
Skin Displacement	-5.87	-7.00	-8.63
	-13.66	-3.09	-5.36
	-5.84	-5.97	-2.55
	-2.37	-7.77	-7.12
	-7.66	-4.7	-
Average	-7.08	-5.71	-5.92
SD	4.15	1.66	2.26

Results:

Anova: Single Factor						
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
5 cm	5	-35.4	-7.08	17.20465		
4 cm	5	-28.53	-5.706	3.46493		
3 cm	4	-23.66	-5.915	6.818167		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	5.372501	2	2.686251	0.286512	0.756314	3.982298
Within Groups	103.1328	11	9.375711			
Total	108.5053	13				

Conclusion:

As the $p > 0.05$, H_0 is accepted and H_a rejected. Therefore there is no significant difference between the levels of skin displacement as drop height is varied.

1.5 Work Done

H_0 : There is no difference between the work done as drop height is varied.

H_a : There is a difference between the word done as drop height is varied.

Dataset Used For Calculation:

	Drop Height		
	5 cm	4 cm	3cm
Word Done	-292.44	-432.30	-240.27
	-28.99	-181.96	-534.93
	501.81	-398.52	-197.93
	-313.13	-473.29	-564.69
	-379.16	-450.15	-
Average	-303.12	-387.24	-386.71
SD	173.65	117.96	194.48

Results:

Anova: Single Factor						
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
Column 1	5	1515.53	-303.106	30155.33		
Column 2	5	1936.22	-387.244	13914.95		
Column 3	4	1546.82	-386.705	37825.86		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	22625.84	2	11312.92	0.429468	0.661315	3.982298
Within Groups	289758.7	11	26341.7			
Total	312384.5	13				

Conclusion:

As the $p > 0.05$, H_0 is accepted and H_a rejected. Therefore there is no significant difference between the levels of work done as drop height is varied.

1.6 Impulse of the Force

H_0 : There is no difference between the impulse of the force produced as drop height is varied.

H_a : There is a difference between the impulse of force produced as drop height is varied.

Dataset Used For Calculation:

	Drop Height		
	5 cm	4 cm	3cm
Impulse of Force	1.70	2.66	0.66
	0.09	2.54	2.56
	2.60	2.56	1.60
	2.56	2.35	2.02
	1.82	2.33	-
Average	1.75	2.49	1.71
SD	1.02	0.14	0.80

Results:

Anova: Single Factor						
SUMMARY						
<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>		
5 cm	5	8.77	1.754	1.03538		
4 cm	5	12.44	2.488	0.02037		
3 cm	4	6.84	1.71	0.6444		
ANOVA						
<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	1.829521	2	0.914761	1.63451	0.239052	3.982298
Within Groups	6.1562	11	0.559655			
Total	7.985721	13				

Conclusion:

As the $p > 0.05$, H_0 is accepted and H_a rejected. Therefore there is no significant difference between the observed impulses of force as drop height is varied.