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Effects of drop height and damper thickness on shock output optimization for hard disk drive reliability

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ABSTRACT – A study of the shock test towards Hard Disk Drive (HDD) was carried out. Experimental results were used to analyze and optimize the suitable parameters, in order to achieve a shock output that excite internal resonant and cause most damages to the HDD [1]. The study revealed the damper and drop height showing importance parameters for shock test.

1. INTRODUCTION

Dropping, striking, or bouncing a hard disk drive against a hard surface can damage it internally without external evidence of damage [2]. Shock effect on HDD is one of the important reliability event, it can states into two tests “Operational” and “Non-Operational” [2]. In general, shorter pulse widths of shock excite higher frequencies and greater amplitudes [3]. In HDD technology, shock inputs required as half-sine accelerations with various amplitudes 150-1000G and short pulse widths in 1-2ms. In order to achieve desired shock output [4], few parameters have proceeded for study its effects. Figure 1 showing T is pulse width; and A is shock amplitude.

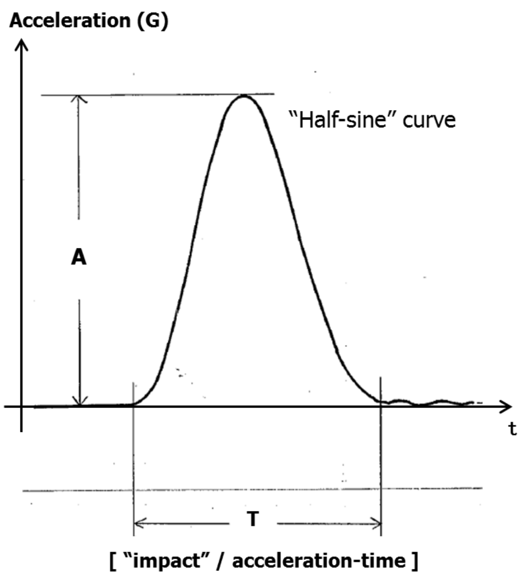

Figure 1 Desired Half-Sine wave shock output.

2. METHODOLOGY

Exploratory studies were performed by using a custom made shock tester. The drop height and damper thickness were varied. HDD was mounted at the center of the stage with the accelerometer mounted at the side. The accelerometer was placed as close as possible to the HDD. The equipment setup was shown in Figure 2. The stage was manually lifted to the desired height and drop freely though the Thomson Shafts. The damper selected was made of foam rubber material with hardness at Shore 40A. This was placed directly beneath the stage on top of the base plate. The contact plate of the stage will directly impact the damper. The size of damper was varied as well, in order to perform shock at different impact, when the upper contact plate hit onto the damper. Accelerometer was used to capture the shock output, which connected to a signal conditioner, and signal output to an oscilloscope. Oscilloscope captured the preset trigger amplitude of shock output, within the particular pulse width. Visual FFT software was used to analyze waveform from the oscilloscope.

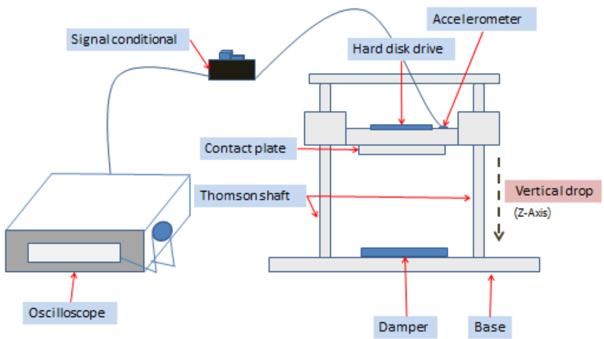

Figure 2 Overview of simple shock tester.

The experiment matrix was shown into Table 1. The drop height was varied from 12cm to 29.5cm. The foam rubber material damper’s thickness from 2mm to 9mm. Impact contact area was either 10.4cm^2 or 1.4cm^2.

Table 1 Drop Height, Damper thickness & shock contact area were used to optimize the shock output.

No.	Drop Height (cm)	Damper Thickness (mm)	Contact Area (cm^2)
1	12.0	2.0	10.4
2	21.0	2.0	10.4
3	29.5	2.0	10.4
4	29.5	2.0	1.4
5	29.5	6.0	1.4
6	29.5	9.0	1.4

3. RESULTS AND DISCUSSION

The shock acceleration increases when increasing the drop height, as illustrated in Figure 3. This tendency can be interpreted in terms of the balance between potential energy and kinetic energy, then proportional to the acceleration [2].

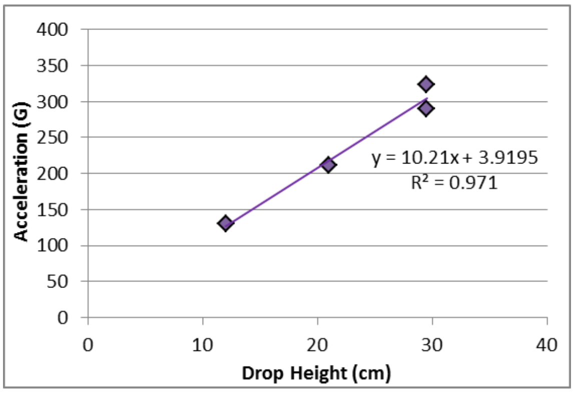

Figure 3 Relationship between drop height and the amplitude of shock acceleration (At damper thickness 2.0mm, and contact area 10.4cm^2).

At drop height = 29.5cm, the shock acceleration decreases when increasing in damper thickness. This is illustrated in Figure 4. This tendency can be explained by shock absorption and duration is higher on thicker damper, thus the shock acceleration is lower.

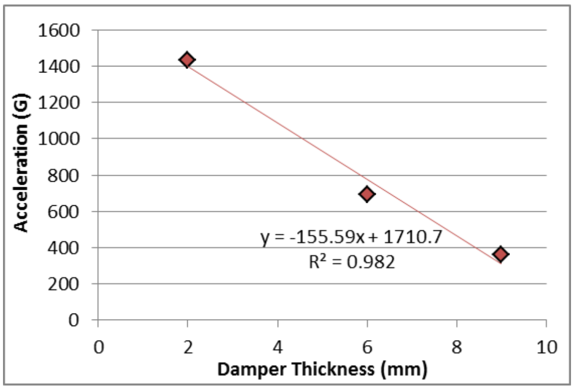

Figure 4 Relationship between Damper Thickness and the amplitude of Shock Acceleration (At drop height 29.5cm, and contact area 1.4cm^2).

Figure 5 show that at drop height = 29.5cm, the shock acceleration increases when reducing in shock contact area to the damper. This is due to the small contact area, causing higher shock impact during contact.

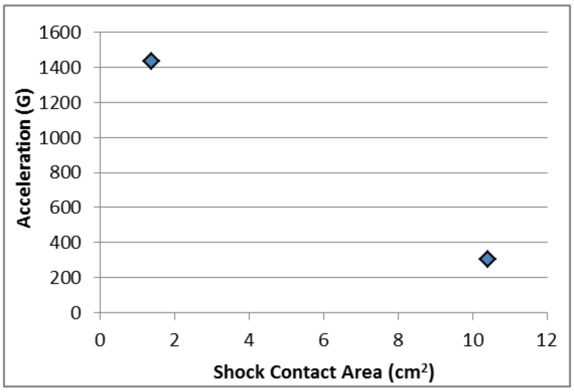

Figure 5 Relationship between Shock Contact Area and the amplitude of Shock Acceleration (At drop height 29.5cm, and damper thickness 2mm).

4. CONCLUSION

The effects of drop height, damper thickness and impact shock contact area towards shock acceleration have been investigated. Clear tendency can be observed among these effects, and these are the important parameters for shock output optimization. This simple shock tester can be optimized, in order to achieve the desired shock acceleration outputs for HDD reliability.

5. REFERENCES

[1] Suresh Kumar, V.D. Khanna, M. Sri-Jayantha, "A Study of the Head Disk Interface Shock Failure Mechanism", IEEE Transactions on Magnetics, vol.30, pp. 4155-4157, 1994.

[2] Feng Gao, "Shock Analysis of Non-Operating Hard Disk Drives based on a Multibody Dynamic Formulation," Microsyst Technol, 12: 247-257, 2006.

[3] Murthy Aravind N., "Investigation of the Effect of Shock, Vibration, Surface Texture and Surface Pattern on the Dynamics of the Head Disk Interface," Electronic These and Dissertations, pp. 1-254, 2007.

[4] Allen, A.M, "Effects of Shock on the Head-Disk Interface," IEEE Transactions on Magnetics, vol.32, pp. 3717-3719, 1996.