Determining Stopping Distance Using Only Drop Height and G-Force

Have you ever had an object that needed to be able to fall from a specified height and be designed to withstand a certain g-force limit? From automotive, sporting goods, packaging machinery and other various industries - these situations are endless.

Sorbothane® is Ideal for Shock Absorption

Sorbothane® is a viscoelastic material and ideal to use on many products and applications as it combines shock absorption, good memory, vibration isolation and vibration damping characteristics. While many materials exhibit one of these characteristics, Sorbothane® combines all of them in a stable material with a long fatigue life. Sorbothane® also has a low creep rate compared to other polymers (rubber, neoprene, silicone, etc.)

Determine Stopping Distance

Whether your challenge is to protect a product as it arrives at end-of-line for packaging and shipment, absorb the impact of a fastball without compromising flexibility or causing rebound in a baseball mitt, or anything in between, learn how to determine stopping distance using only drop height and g-force levels.

Calculating Stopping Distance

Starting with the equation of acceleration:

$$a = dv/dt = (v - v_0)/dt$$

where v = 0 because that is the end of the travel where the object is stopped and dt is the time it takes to stop so

$$a = - v_0/t.$$

The next step is to calculate the time. Using the mean speed theorem or Merton rule of uniform acceleration, we can use the average velocity to represent the entire velocity over the event so

$$v = 0.5 * (v - v_0)$$

where again v = 0 so

$$v = - 0.5 * v_0$$

and it is negative because it is deaccelerating. Then knowing the equation for velocity is

$$v = dx / dt$$

where dx is the stopping distance and dt is the time, substitute in the average velocity so

$$-0.5 * v_0 = x / t$$

Solve for t and

$$t = x / (-0.5 * v_0) = -2 * x / v_0$$

Now substitute $t = -2 * x / v_0$ into $a = - v_0/t$ and you get

$$a = v_0^2 / (2 * x)$$

Then solve for x and

$$x = v_0^2 / (2 * a)$$

Then you just have to solve for the velocity at impact, v_0, which you can get from the third equation of motion

$$v^2 = v_0^2 + 2a(s - s_0)$$

where in this case v_0 is zero because it is before the drop, acceleration is just gravity and $s - s_0$ is the drop height which I will call ‘h’ so

$$v = \text{square root } (2*g*h)$$

Substituting this back into the stopping distance

$$x = (2*g*h)/(2*a) = g*h/a$$

Finally, knowing that g-force is just a ratio of acceleration to gravity (g-force = a / g), you can rearrange the equation to

$$x = h/(a/g) = h/\text{g-force}$$

So, for example, you have an object falling 48 inches and the g-force limit is 40 g's. Plugging these into the equation, you get x = 48 inches/40 g's = 1.2 inches which will be the minimum amount of deflection needed from a padding.

Factoring Stopping Distance and Sorbothane

Going further, knowing the maximum recommended dynamic deflection on Sorbothane is 60%, you can divide the 1.2 inches by 0.6 (60%) to get 2 inches which is the minimum thickness you should use of a Sorbothane pad.

Impact Calculator

Now that you have a better idea of how stopping distance can be calculated, feel free to check out our Engineering Design Guide to calculate the geometry and durometer needed to get that 1.2" dynamic deflection. If you want an easier way to calculate this, our Impact Calculator automates these equations to save you time.

Sorbothane Standards

Sorbothane® - Proven Shock, Vibration and Noise Reducing Solutions – 100% Made in America

Since the beginning - Sorbothane® has been made at our 64,000 sq. ft. plant in Kent, Ohio - USA.

APMA - Ensuring Quality

In 1986 Sorbothane® was granted the American Podiatric Seal of Acceptance. The APMA Seal of Acceptance and Seal of Approval are granted to products found to promote good foot health. The Seal of Acceptance is awarded to shoes, socks, insoles, materials and equipment.

Sorbothane Material Data Sheets –
http://www.sorbothane.com/technical-data-sheet.aspx

www.sorbothane.com

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