Hard Openings

6/21/2013

The cause of hard openings is a subject of much speculation. I believe that we must start any analysis with the premise that "if a parachute opens soft one time then it is capable of opening soft every time". Assuming that, logic then says in order to repeat soft openings we must control all variables involved. That is, all of the variables that go into controlling opening shock must first be identified with their particular variability. To begin that process we must first understand all about opening shock. When we talk about hard openings we must delineate between types. There are openings which merely deflate your lungs and there are openings which do serious physical damage to you and or your gear. We will concentrate on the latter while trying to cover the complete spectrum.

Before I go into the technical part of this article, I must say something about jumper perception of opening shocks. This is best illustrated by relating a conversation with an old friend of mine who was doing some test jumping for another parachute company. He told me about making a jump on one day with a data logger, to record force, and getting a normal opening shock. Using the same pack job and again with a data logger made a jump the second day and it slammed him. The data from both jumps showed the same relative force, but the jumper felt the second jump was much harder. This is due to preparedness or lack thereof, of the body and mind before deployment. It is due to the way you feel on a given day and is not what we are looking for in terms of analysis of potentially destructive openings.

Opening shock can be divided into basic components; "Snatch Force" and "Inflation Force".

Snatch force is that point in the deployment when the mass is accelerated to speed. This simply means when everything (lines, canopy, and bridle) is stretched out with tension and load. When that load occurs you are at snatch. This is also when the slider is beginning to take air. Hopefully the slider won't take air until just after snatch. This can be helped by rubber banding the apex of the slider to a center B or C line attachment to momentarily retain it.

Inflation force, on the other hand, normally occurs after snatch and has less force than snatch. It is when the canopy begins inflation and commences the argument between the resistance of the slider and the inflation forces spreading the canopy. This usually occurs in steps of decreasing force. There are canopies which have a greater inflation force than snatch force. This is not to say they occur out of order but that one part of the opening is greater than the other part. Yes, those types of canopies are known to be hard openers but do not necessarily produce the catastrophic type of openings we are trying to define.

What is described above is what should happen on a normal opening and does in fact occur on most deployments. Allowing deviation from this sequence will most likely cause higher than normal opening force. The one thing we must avoid is allowing

“Inflation” to occur before “Snatch” or to allow them to occur simultaneously. When that happens, people get hurt. When inflation occurs before snatch it is call a “canopy first” deployment. That is the way all parachutes opened in the beginning, then the French invented the “Sleeve” and created “line first” deployment. The D-bag is a later development replacing the sleeve. Early squares did use a short sleeve.

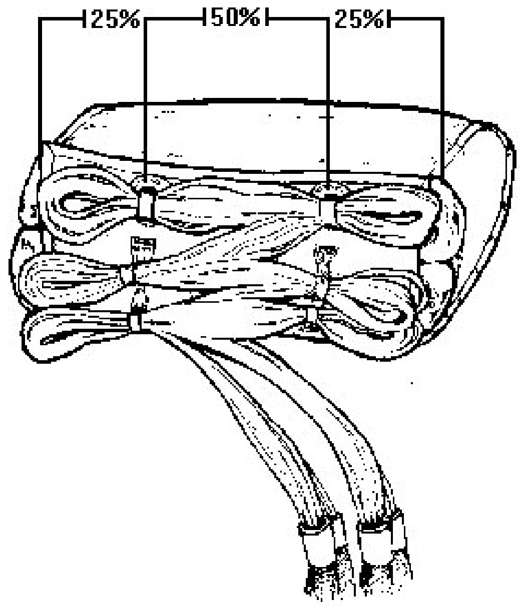
Let us now look at the individual components and break down their function and foibles.

Canopy design: Some of the major canopy design variables are slider size, nose angle, trim angle, cell size and brake setting. If one of them is incorrect your first jump will be hard and you will know it. When this is the case then all of the openings will be hard. The only thing you could do, in the field, is change the slider size or sometimes an adjustment of the deployment brakes can help. Some people have claimed that the line type has an effect. I accept the fact that there may be an effect from line type or weave or the friction of pulling the lines from the rubber bands but I don’t see it in data acquired during many opening shocks recorded. If there is an effect it must be minor.

Pilot Chute drag: Large high drag pilot chutes can cause some increase in snatch. I know of cases where a smaller pilot chute did solve the problem. However, this again is not the problem we are looking for. We want to know about catastrophic openings, the kind that destroys. To find those variables responsible for this phenomenon we must move on, defining functions and variables.

Deployment Bag design: The D-bag is the single most important component in this equation. There is much conversation and disagreement about this subject. Here is my take. The D-bag is used to prevent the canopy from taking any air or opening prior to an orderly, properly sequenced line deployment. We use the suspension lines stowed in rubber bands to keep the bag closed. There are other devices designed to do the same job and the phenomenon described here is applicable to all of those devices. If the bag is allowed to open prematurely, exposing the canopy to inflation you will have a very hard “canopy first” opening. These openings may vary in intensity depending on exactly when in the process of deployment the canopy inflation begins. We want inflation to be the last thing that happens. This malfunction is referred to as line strip/dump or “out of sequence deployment”. The lines being released from the bag prematurely and allowing the canopy out is, in and of itself not the complete cause of these catastrophic openings. The slider, being allowed to fall down the lines away from the bottom skin allowing the initial inflation to occur simultaneously or prior to snatch is the cause. The amount of inflation is dependant on the resistance of the slider and the geometric size of the bottom of the canopy, at that instant, which is created by the trapezoid defined by the bottom plate of the canopy, the slider, and the lines between them. In other words the more the slider is allowed to drop the more deadly the shock will be as more surface area is exposed. This may be ameliorated by retaining (rubber banding), the slider. Some manufacturers use a snap to hold the slider to the canopy in place of a rubber band. While either will help in most cases neither is a panacea. These devices are designed to release upon inflation. If the canopy begins rapid inflation just off your back it will spread causing the slider to release and fall quickly down the lines before you reach the end of the lines. You really don't want your slider to beat you to the end of the lines.

What causes the lines to release from the bag allowing the canopy to get out prematurely? Inertia is the answer. Newton said "Bodies at rest tend to stay at rest; bodies in motion tend to stay in motion. A body is a unit of mass. Lines stows are divided into 3 units of mass. They are; the bights, 2 each, and the span or the part of the lines between the stows or bights. Each of these components, separated by the stow rubber bands, is a unit of mass within itself. The mass of the 2 bights must equal the mass of the span. In terms of percentage the span should make up 50% of the entire line stow from side to side. We want 25% in each bight so as to equalizes the tendency of the span to "drop out" or "Dump" or "Strip" or pull the bights out of their stows, upon extraction from the container, by overcoming their mass.



The combined mass of the bights equalize the downward force of the span portion of the lines as they try to stay in the pack tray upon bag extraction. If the mass of the span is greater than the mass of the bights then it will pull the bights out of the stows upon extraction from the container. If the span is, say 70% of the entire line stow from side to side that only leaves 30% to be divided by each bight or 15% per side. The 70% in the middle will easily overcome the 15% on each side. Some people double wrap the stow bands to help keep the line bights retained. That is a "brute force" method of keeping the lines in place and doesn't always work. I am sure most of us have seen pictures of the span portion of the lines drooping in an arc as the bag is extracted. That droop is trying to pull the bights out of the rubber bands and open your bag.

This is a line dump in process. Note the stretch of the rubber bands and that the canopy has already escaped the locking stows. Note also how the canopy is "slumped" in the bag. All of this is caused by inertia. This is a tandem with a collapsed drogue and large rubber bands which should produce a reduced Snatch. How much force do you think it takes to stretch those rubber bands?

How well do you think this bag would retain the lines?

High speed is where the most severe openings occur. The higher the Dynamic Pressure or "Q" the more things drag and the greater the differential of mass inertia. In order to endure these forces the deployment must be smooth and progress evenly throughout the process. The spread of your arms in freefall will do more to change the nature of the opening than any normal pack job. In other words slow down when you deploy; it will soften the shock. It is important to pack consistently from jump to jump. It is also important to utilize the same body position with the same speed if you want repetitive openings. I believe in keeping my shoulders level to the ground and rotate from flat to vertical, through an axis defined by my shoulders, during deployment. This allows for air flow over my back to sweep away any burble and it positions me, sitting into my saddle. I use my arms to take some of the opening load by grabbing my risers with my hands during inflation. This has me ready to take command of my canopy. Be careful not to get you fingers between the risers, they bite. I never look over my shoulder to clear a burble. I look straight up over my head and that keeps my shoulders level. Uneven shoulders mean uneven line tension. Looking over your shoulder usually causes you to drop a shoulder making your body into a propeller. While your body might not start to rotate the air above you does and it spins your bag causing line twist.

In conclusion I would like to mention the new trend in D-bags which is to reduce or eliminate the stows. I have seen some that look like they might be OK and I have seen some that make me run away. The most telling comment I have heard about them is that they don’t work so well on tandems. If you understand all I have said previously then you know why.