AN INNOVATIVE HARNESS/CONTAINER ASSEMBLY FOR SPORT PARACHUTES

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REZUMAT. Lucrarea prezinta proiectarea si dezvoltarea unui ansamblu ham/container inovativ pentru parasute sport compatibil cu mai multe tipuri de voaluri. Ansamblul ham/container constituie sistemul de siguranta al parasutismului, controland deschiderea parasutelor. Volumul variabil al compartimentului parasutei de rezerva a fost obtinut prin adaptarea lungimii buclei de inchidere a compartimentului iar volumul variabil al compartimentului parasutei principale prin utilizarea unei umpluturi suplimentare ce reduce volumul compartimentului.

Cuvinte cheie: parasuta sport, ham, container, voalura, volum compartiment

ABSTRACT. The paper presents the design and development of an innovative harness / container assembly for sport parachutes, usable with several types of canopies. The harness / container assembly is the parachute's safety system, controlling the opening of the parachutes. The variable volume of the reserve parachute compartment was obtained through the length of the reserve closing loop and the variable volume of the main parachute compartment with a filling pocket that can be used to reduce the container available volume.

Keywords: Sport parachute, harness, container, canopy, compartments volume

1. INTRODUCTION

The Harness/container assembly is intended for sport parachute jumpers.

The harness/container assembly is the safety system of the jumper. The container controls the deployment and opening of the canopy and the harness connects the parachutists with canopy. The container is designed to take over and maintain main and reserve parachute canopies in a folded state. Containers for sport parachutes have two compartments, the bottom compartment for main parachute and its subassemblies and the upper compartment for reserve parachute and its subassemblies [1]. Sports containers have distinct requirements for main parachute compartment and for reserve parachute compartment. Currently the compartment sizes of the reserve and main parachute canopy are made in accordance with the volume in folded state of the parachute. For example, ICON containers are designed and manufactured in 9 sizes for 9 different volumes of the reserve parachute and 9 different volumes of the main parachute, both in a folded state [2]. Quasar II containers are designed and manufactured for 9 different volumes of the reserve parachute in folded state and for each reserve parachute between 1 and 4 volumes of the main parachute in the folded state [3]

Designing the reserve parachute compartment can be done in two ways: with the pilot chute inside the container or outside. The design of the main parachute compartment is less restrictive than that of the reserve parachute.

The main parachute compartment has a parallelepiped shape.

Harness standard configuration is made as to secure the torso, head, arms and legs with straps, survival kits or cushion material. The suspension system (harness) is integrated into the container. The most manufacturers make the harness custom sized.

Our innovation is a container with a larger compartments volume, which can be reduced to the different volume of folded canopies and a harness in a unique adjustable size.

The assembly, in conformity with AC 105-2D, it consists of the canopy, deployment device, pilot chute and/or drogue chute, risers, stowage container, harness, and opening device (ripcord).

The proposed solution is patented pending.

2. EXPERIMENTAL WORK

2.1 Harness/container assembly subcomponents and performance requirements

We designed the container considering the requirement for the correct opening. The harness was designed and developed in a unique size but

must to be comfortable to wear, to fit all people between 150 cm and 200 cm and 50 kg to 120 kg weight with winter clothing, the ripcord device to operate quickly and safely at an effort of up to 10 kg, to be simple body adjustments visible and to support the body safely.

The materials used in the manufacture of the assembly are standardized as parachute materials. In the assembly the main materials used were: 1000 denier Cordura fabric with 300g/m2, breaking strength of 300daN and abrasion resistance of at least 50,000 cycles Martindale (MIL-C-43734, class 3) and for harness webbing with 43 mm width and 2700 daN breaking strength (PIA-W-4088).

Figure 1 presents the innovative harness/ container assembly developed and its subcomponents.

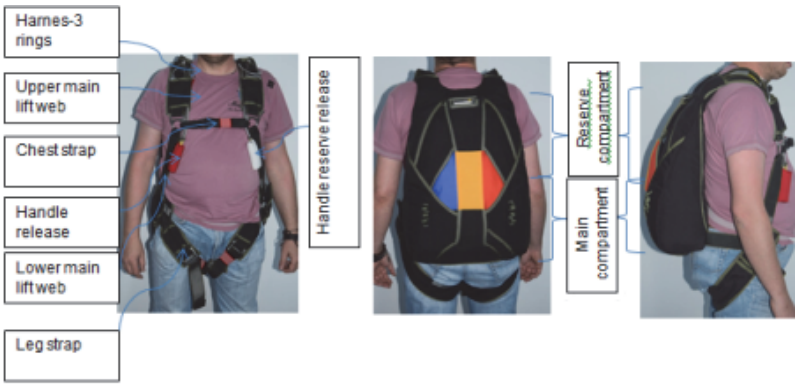

Fig. 1. The harness/container assembly and its subcomponents

2.2 The innovation solution

The volume of the deployment bags and of the container compartments was calculated as follows:

a) the rectangular bag of the main parachute

$$AB \cdot h \quad (1)$$

b) the truncated cone bag of the reserve parachute

$$\frac{h}{3} \cdot (AB + Ab) + \sqrt{AB \cdot Ab} \quad (2)$$

where: AB - the large base area of the parallelepiped or truncated cone; Ab - the small base of the truncated cone; h - the height of the parallelepiped or the truncated cone.

In order to achieve a variable volume of compartments we use a variable h.

For the reserve parachute compartment, h variable is obtained by adjusting the length of the closing loop length.

The main parachute compartment is made at the maximum volume. The volume variation of the main parachute compartment is made by using an extra fill that completes the volume difference between the compartment and the parachute. The filling is placed in a pocket applied on the inside of the main compartment panel, closed with Velcro tape.

2.3 Volume testing method

The "variable volume of the compartments" characteristic was tested by equipping the container with different types and volumes parachutes provided by the Romanian Airclub.

We mention that the parachutes were from different producers as Aerodyne Systems, In. [2], Para-Flite [4], Skylark [5] and Flight Concept International [6].

To be noted that the volumes of parachutes with the same surface, in the folded state, may vary depending on the type of canopy fabric and the type of the suspension lines. The characteristics of the parachutes used in testing the volumes of the container compartments are shown in Table 2.

Table 2. **The characteristics of the parachutes used in testing the volumes**

Parachute type		**Producer**	**No. cells**	**Certified volume, cm³**
Reserve parachute	Swift 200	Para-Flite	5	6769
	Smart 220	Aerodyne Research	7	7572
	Smart 250	Aerodyne Research	7	7752
Main parachute	Skylark SK 190	Skylark	7	6785
	Solo 270	Aerodyne Research	9	8637
	Manta 290	Flight Concept	9	9340

3. RESULTS

The container compartment for reserve parachute was closed correctly with all three types of parachutes. The volume of the compartment was

adapted to the parachute volume by length of the closing loop as following:

- Swift 200 parachute: 10,5 cm
- Smart 220 parachute: 12,5 cm
- Smart 250 parachute: 14,5 cm

Fig. 3. Flight test of Harness/container assembly

The container compartment for main parachute was closed correctly with all three types of parachutes; this was easily varied by using the extra volume in the created pocket.

For the performance tests, the Harness / container assembly prototype was equipped with the Skylark main parachute and Swift reserve parachute.

The Harness/container assembly was tested in flight at different wind and air speeds, figure 2.

4. CONCLUSIONS

The assembly run test, with the normal folded state of parachutes has been achieved with a manikin of 77kg at different aircraft speeds. This test showed that both harness and container performed without delays.

The harness made in a unique size was:

- comfortable to wear with a simple body adjustment;
- suitable for people with body height between 150 cm and 200 cm and 50 kg to 120 kg weight with winter clothing;
- the ripcord device operates quickly and safely at an effort of up to 10 kg;
- supports the body safely.

The container can be equipped with:

- reserve parachutes with a volume in folded state between 6769 cm^3 and 7752 cm^3;
- main parachutes with a volume in folded state between 6785cm^3 and 9340cm^3;

At the flight testing:

- the reserve parachute was fully opened in less than 3 seconds from the launch of the 77kg payload
- container at wind speeds of 5.5 m/s and 6.5 and the air speeds of 111 km/h and 130 km/h;
- the main parachute were correctly opened;
- no damage to the fabric and stitches of the container and harness.

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