Parachute free airdrop packaging box application environmental testing technology overview

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Abstract. Parachute free airdrop delivery method has gained widespread popularity in recent years due to its precise and efficient security benefits. As a critical technical solution for Parachute free airdrop of small equipment and equipment, guns and ammunition, and medical equipment and other materials, relevant tests and research are gradually launched. This paper discusses the design objectives of the Parachute free airdrop packaging box, organizes and summarizes the application environment for the Parachute free airdrop packaging box, describes the design environmental conditions and environmental tests for the Parachute free airdrop packaging box, and provides preliminary technical indicators for the design and development of packaging box products and test devices.

Keywords: Parachute free airdrop packaging box; application environment; design environmental conditions; environmental test.

1. Introduction

The term "parachute free airdrop" usually refers to an airdrop method that does not use a parachute, i.e., one that does not use a descent control device or deceleration technology to reduce the effect of gravity on the rate of descent. The only way to overcome the shortcomings of road and rail transportation, and solve the problem of low efficiency of airdrop with parachute, with short preparation time, easy operation, small scattering range, rapid collection, and many other advantages, is to realize the field of harsh natural conditions, complex and changing terrain, and harsh combat situation equipment, supplies in real time, and accurate point-to-point security [1].

Because of the constraints of packaging structure design and packaging buffer material technology, parachute free airdrop technology has been slow to develop in comparison to mature parachute airdrop technology. Traditional parachute-free airdrop buffer packaging, which primarily consists of honeycomb paper, tonnage bags, polyurethane foam, and other materials, can be used for oil, clothing, and food delivery, but research into parachute-free airdrop packaging for equipment, weapons, and ammunition is still in its infancy. Universal parachute free airdrop packaging box is a better technical solution for small equipment and equipment, guns and ammunition, as well as medical equipment and other materials [2].

Based on existing published literature and test data from relevant institutions, this paper summarizes the application environment of parachute free airdrop packaging boxes and provides design environmental conditions and environmental test methods for parachute free airdrop packaging boxes to provide preliminary technical references and design indicators for the design and development of packaging box products and test devices.

2. Parachute free airdrop packaging box design objectives

In comparison to standard packing box design requirements, a parachute free airdrop packing box must first be able to withstand the strong landing impact of a parachute free airdrop, then provide good buffer protection for internal materials, and adapt to complex mission environmental conditions. The structure design is shown in Figure 1 and is mainly composed of five parts, including: The main function of the outer box is to serve as a direct impact structure, with sufficient strength and toughness to ensure that the landing impact is not broken and that local deformation does not affect the use of

small; inner box, its main function is to provide structural support, to avoid excessive deformation extrusion packaging object; inner buffer protection layer, its main function is to absorb the kinetic energy of the material impact, to play a buffer protection role; air-dropped materials, emergency supplies that can withstand a certain intensity of impact;

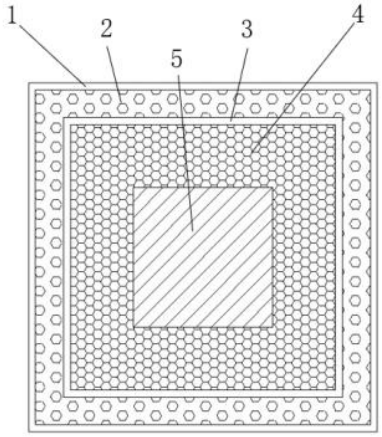


Figure 1. Parachute free airdrop packaging box structure schematic diagram.

1. Outer box body; 2. Outer buffer isolation layer; 3. Inner box body; 4. Inner buffer protection layer; 5. Airdrop materials

The specific design objectives of the Parachute free airdrop box are summarized as follows.

The box has sufficient protection in the following mission environments.

1. The landing ground is concrete, deck and other rigid non-yielding ground when the airdrop airspace 0-100m.

2. 0-200m when the landing ground is grass, sand and other non-yielding ground.

3. When the airdrop is not hovering airdrop, the landing synthetic speed is 0-60m/s.

The packing box for an airdrop without a parachute should be designed in such a way that

1. The packing box's outer box does not crack or deform as a result of the landing collision; it can be stacked normally and used for switching.

2. Suitable for air, road, and railroad transportation, the structure should be balanced and stable to prevent backward stacking during transportation, storage, and stacking.

3. A moisture-resistant, rust-resistant, and anti-static coating.

4. With a structure that maintains a balance of internal and external air pressure during the delivery and transportation of air.

5. To ensure that the rate of material damage during delivery is kept within a manageable range.

Additionally, packaging box design should consider the following requirements.

1. Uncomplicated and simple to operate.

2. Able to withstand prolonged and repeated use.

3. The selection of materials that are both safe and environmentally friendly, as well as affordable in terms of cost and maintenance.

4. Attempt to increase the payload ratio of materials dropped by air.

3. Parachute free airdrop packing box application environment

Combined with Parachute free airdrop box mission requirements to carry out research on climatic conditions, airdrop landing environment, airdrop delivery environment, etc., combing the main application environment of parachute-free airdrop packaging box.

In terms of environment and climate, it is an important task of Parachute free airdrop to provide peacetime and wartime emergency material delivery for the highland alpine, mountainous, island and other border and naval defense forces, and the climate environment is diverse, so Parachute free airdrop packing boxes should adapt to the main climate conditions within the territory of China, and

Parachute free airdrop packing boxes may involve road transportation, railroad transportation and waterway transportation in addition to air transportation, after comprehensive consideration, its main climate and environmental conditions are sorted out in Table 1[3].

Air drop delivery environment impact factors include delivery density, delivery machine speed, delivery height, etc. Among them, the delivery machine speed and delivery height mainly affect the impact strength of airdrop landing, Parachute free airdrop box delivery height and delivery machine speed is not yet a clear standard, with reference to the military standard requirements for food Parachute free airdrop delivery height and fixed-wing aircraft delivery safety height, Parachute free airdrop box delivery height is generally not higher than 100m, landing combined speed does not exceed 50m / s.

Table 1. Main climatic conditions.

Climatic environment	Road transportation	Railroad transportation	Waterway transportation	Air transport
Low temperature	-50 ℃	-50 ℃	-25 ℃	-50 ℃
Humid heat (95%)	45 ℃	30 ℃	40 ℃	30 ℃
Low pressure (kPa)		Below 3000m: 70	Below 3000m: 70	Non-sealed chamber: 25
High temperature	Sealed compartment: 70℃; Ventilated compartment: 5℃			
Rainfall intensity	0-0.7 mm/s			
Solar radiation	Altitude below 3000 m: 1120 W/m2; above 5000 m: 1250 W/m2			

The main factor of airdrop landing environment is the type of airdrop site, including grass, swamp, sand, gravel ground, steel deck, concrete ground, asphalt ground, water surface, etc. (see Figure 2), generally choose the ground surface layer is softer site. Among them, the steel deck concrete ground is yielding ground, rigid collision is easy to cause damage to the box material, gravel ground is easy to form puncture damage, water surface, swamp, etc. easy to cause seepage problems. top left to top right:Water surface, concrete floor, steel deck;bottom left to bottom right:Snow, gravel, grass.



Figure 2. Typical type of airdrop site.

4. Parachute free airdrop packaging box design environmental conditions

According to the above Parachute free airdrop packaging box application environment, this paper proposes Parachute free airdrop packaging box identification test conditions [4].

Transportation and storage environmental test conditions.

1. Temperature: used in the environment of -50℃~70℃.
2. Relative humidity: RH 5%~100%.
3. Low air pressure: 25 kpa.

4. Stacking height not less than 5 layers.
5. Atmospheric salt spray 2 mg/m3.
6. Solar thermal radiation: 1130 w/m2.
7. Rain shower: 0.7 mm/s.
8. Vibration: frequency range 2 ~ 20000 HZ, power spectrum density spectrum specific form corresponding to a variety of transport vehicles.

Task environmental test conditions.

1. Non-yielding surface collision: concrete ground, arbitrary collision angle, collision speed 44.7 m/s;
2. Breakdown collision: gravel ground, arbitrary collision angle, collision speed 44.7 m/s;
3. Yield surface collision: sandy ground, any collision angle, collision speed 65 m/s.
4. Carry out water immersion test, when the total mass of the packing box is not more than 80% of the total mass of the box drainage, can float on the water surface for more than 3 hours, and keep the box materials dry.
5. Repeatability test: any collision angle, collision speed 45 m / s, intermittent collision 20 times.

5. Parachute free airdrop packaging box environmental test method

The identification of parachute-free airdrops in transport and storage environments is generally conducted in accordance with applicable national military standards. The impact test is the most critical environmental test of the Parachute free airdrop packing box, and the primary test methods are as follows [5]:

1. Actual drop test via airdrop. Utilizing a large-load UAV as test equipment, the test box is tethered to the UAV and is pulled up to a specified height by the UAV. Once at the specified height, the tether is untied and the test box free falls to a predetermined speed collision with a predetermined fixed ground target (see Figure 2). Air resistance and ground airflow have an effect on the method; landing collision angle control is more difficult and is typically used for stage identification tests.



Figure 3. Uav airdrop test.

2. Centrifuge examination. The test employs a centrifuge as the impact testing apparatus, allowing for the screening of impact-resistant structures and materials. Schematic diagram of Centrifuge examination principleis shown in Figure 4.A fixture is used to secure the packing box specimen to the end of the centrifuge arm. When the centrifuge rotates at an angular speed ω, the packing box is released from restraint and the specimen flies out along the tangential direction of the rotating track at a speed of $v = \omega R$ (R is the length of the centrifuge arm) and then collides with the pre-set target (the distance between the target and the centrifuge is controlled to prevent the specimen from jumping back to the centrifuge). The test method not only can control the collision speed but also can constrain the collision angle within a certain range.

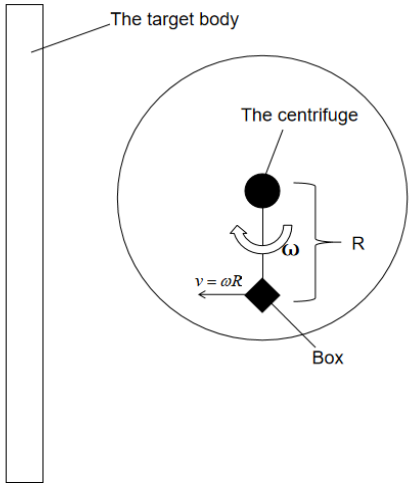


Figure 4. Schematic diagram of Centrifuge examination principle

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