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Advancement in Inflatable – "A Review"

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Abstract

With the increase in a continued human inquisitiveness, work has been done in the development of inflatable structures. The concept of inflatable structures includes light-weightiness and deployable parts. These parts utilize the theory of membranes, hybrids and composites. These inflatable structures offers great advantage for the building of Convertex emergency air shelter, Balloon used in defense sector, Military tents, Stadium cushions, impact guards, vehicle wheel inner tubes, emergency air bags and so on. Apart from this they also prove their importance in space stations for building of the terrain on moon and mars too. These light weight structures are of particular interest due to the requirement of small storage space in deployed condition, their maximum load capacity and their adaptable frame-work. The paper presents a review of the advancement and innovations, both in its prior and current phase, in inflatable technologies.

Keywords: Inflatables, light-weightiness, deployable, maximum load capacity, adaptable frame-work.

1. Introduction

Scurlock (1959) conceptualized the first inflatable in Shreveport, Louisiana. He is a pioneer of inflatable tents, inflatable domes. His tremendous accomplishment was the introduction of the safety air cushion. These cushions are used by fire and rescue department. Scurlock (1986) established the first Fun factory in Metairie, Louisiana. This factory was overall made of inflatable. In 1967 a pressurized top known as "Space walk" was incorporated. This space walk use to get hot in summer. Thus for its enhancement "Jupiter Jump" was added, which consists of net walls over inflated columns. In addition to this further castles and animals were developed. And this was known as inflatable zoo. The first commercial water slide known as "Aqua slide" was created by frank in the year 1990.

Due to its advantage of light weightiness and ease of transportability, inflatable has being the area for research since our past and more over it has been attracted even today's genesis toward itself in its commercial application, civilian applications as well as in defense too. Apart from this it has also expanded its arm towards the space application. Inflation is done either with air or with gas. Hydrogen, Helium and Nitrogen are preferably used gases .In addition of providing advantages of light weightiness their small storage capacity in deployed condition has also proven the centre for its attraction. This paper presents a brief review of the foreground of the work that has been done in inflatable's advancement.

2. Advantages

The most attractive feature of inflatable is their light weightiness and ease of transportability. Department of Parks and Recreation, Department of Rescue and Fire Management, Department of Space technology and other departments too has analyzed the application of inflatable for various purposes. Moreover they are in practical demand too. And in mostly they are found more competitive due to the following reasons-

1. These are light in weight and provides up to 50% reduction in the system weight. Moreover use of thin material provides good strength.
2. In deployed condition these can be stored in less space, around 25% less than an erectable structure. Moreover its ability to be packed in any shape is also discriminatory.
3. It has a long lasting load bearing capacity. And the structure provides good strength to the system.
4. In inflatable the surface distortion acts the restoring force i.e. the inflation pressure. Thus they provide a plausive dynamics.
5. In inflatable there is a reduction in temperature gradient due to efficient exchange of radiation. And this result in 10 K or less difference of temperature between a sunlight and shadowed element.Moreover recent development in materials provide with lesser value of thermal expansion.
6. The cost of production and handling provided by inflatable material is very low.
7. These are compatible to any shape either be symmetrical or may be curved one.

3. Inflatable Structures

3.1 Air- supported Structure

Geiger (1970) developed the concept of inflatable structure in an expo in Osaka, Japan. Any permanent structure that derives its shape as the outcome of internal pressure is termed as an air supported structure. The technology of these structures reveals that the internal pressure of the structure should be equal to or greater than the external pressure. Main advantage of air supported structure is that they are easy to take down and additionally provides ease of transportability. Also, they can withstand harsh and severe environmental conditions.

3.2 Airshelters

These are air supported, durable shelters for emergency services and for short term use. High quality fabrics are used with welded seams for its manufacturing. Some of the specific emergency shelters are designed for cold weather conditions. These shelters when set up, takes up an elongated tapered shape from head to foot end. As an additional attachment they are provided with air tunnel shaped doors. These are compact, simple to handle, and portable. Air shelters in the in size of 5 x 5m or 7.5 x 5m are the standard available shelters. These can be deployed even with minimum man power.

3.3 Tents for Military Purpose

The main purpose of inflatable tents was to develop structure that may be quickly and easily deployed, easily erected and may be deflated whenever required. In deployed condition these are easy to store and transport. These tents provide shelter in movable condition ranging from desert area to the arctic regions. These tents can also be utilized for Helicopter and Aircraft Shelters, Mobile Military Checkpoints, for Medical applications, Aircraft Crash Investigation and for many more applications. These tent structures in some cases comprise of a flexible canopy, a series of inflatable tubes that may serve as frames and a floor.

4. Inflatable in Space Research

4.1 Inflatable Reflectors

L'Garde Space inflatable reflector are the recent field of development in space research. These L'Garde space reflectors are generally parabolic and conical in shape. This comprises of two surfaces- a parabolic surface and a symmetric canopy. Now these two surfaces are joined together with flexible ring. As a result it forms a closed surface that can be inflated. As the optical properties of both the reflectors as well as canopy are of specific importance, thus, they are customized as per the required absorptivity, emissivity, reflectivity and other optical properties.

4.2 Inflatable satellite

M. Thomas in his paper "Inflatable space structure" has shown that inflatable have been recognized as an innovative tool for space programmers' too. A variety of inflatable satellites have been developed by NASA. The important ones among these are the ECHO I and ECHO II; a passive communication satellite, EXPLORER I and EXPLORER II, PAGEOS – an earth matric measurement satellite.

5. Inflatable Booms

5.1 Inflatable Boom

These are extremely light in weight and provide high packaging ratio up to about 1/45.But these less stable with less deployment accuracy.

5.2 Telescopic Boom

These are comparatively stiffer and more stable than others. It provides stowed length of about 1/10 of the deployed length. But these are heavier and provides low packaging ratio.

5.3 ARTICULATED Booms

The mobile servicing system resembles to an articulated booms. In fully deployed condition it stretches up to length of approx. 17.6 m. It consists of 7 joints each with one degree of freedom and with 360 degree rotation capability. L Puig has moreover shown in the paper that these are also equipped with sensors and cameras.

6. Other Inflatables

6.1 Air/Gas Filled Balloons

Faraday (1824) invented the first rubber balloon. Flexible bag when inflated with gas such as helium or with air is known as 'balloon'. These balloons are used for metrological purpose, in defense sector as balloon barrage and in many more applications. Low cost, light weight and low density of balloons have led towards its wide range of application. Faraday (1824), In World War II, there was establishment of British balloon command. This British balloon command protected the harbors, cities and the ports.

6.2 Tyres

A ring-shaped covering which fits around a wheel rim for its protection is termed as tire. Its purpose is to provide a flexible cushioning effect and to absorb the shock. Natural rubber, synthetic rubber, fabric and wire, along with other compound chemicals are the material commonly used for the tires. The very first tire was simply bands of metal that was fitted around a wooden wheel. It prevents from the wear and tear.

But nowadays, as we have inclined towards inflatable and light weight materials, a large number of tiers are pneumatic inflatable structures.

6.3 Inflatables for Decoration

With the advancement of 2000's, plastic blow molded decorations that were used as Christmas décor have been replaced by inflatable. Synthetic fabrics of different colors stitched in different pattern are used to fulfill the purpose. Many popular characters as Winnie the Pooh, Santa and snow man for Christmas and many more are being produced as decorative inflatable.

6.4 Inflatable Boats for Rescue Operations

Mitchell (1969) first proposed the idea of rescue inflatable boats that could be inflated quickly under any circumstances. The first Inflatable Rescue Boat was around 4 meters in length, was developed by cooperation with Dunlop Company. It was supported by 20 hp outboard motor. These are also known as "rubber duck" or simply "duck". "Rubber" is commonly used for the construction.

6.5 Inflatable Robot

Inflatable have proven their importance in the field of robotic too. Literature shows that a space robot (patent) has been designed which is composed of inflatable links. Revolute joints are used to separate these links. These mechanical joints are heavier. Thus research has been done to replace these links by inflatable. A literature on" novel robot" shows the study of replacement of these mechanical links by inflatable materials. Thus, robots totally designed by inflatable are also enhancing the importance and exposing the technique.

7. Summary

Development in inflatable technology has been continued for the last three decades. Many commercial, non commercial ,space missions' ,defense inflatable systems have pay off precious success to the society as well as to the country. The ongoing development of material has proven itself to be more cost efficient, more stable and more compatible towards complex shapes. More over their thermal behavior and mechanical load carrying capacity are more challenging and competitive. It has proven a boon in the field of technology development.

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