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Methods of configuration test and deformation analysis for large airship

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Abstract: In recent years, high-altitude aerostats have been increasingly developed in the direction of multi-functionality and large size. Due to the large size and the high flexibility, new challenges for large aerostats have appeared in the configuration test and the deformation analysis. The methods of the configuration test and the deformation analysis for large airship have been researched and discussed. A tested method of the configuration, named internal scanning, is established to quickly obtain the spatial information of all surfaces for the large airship by the three-dimensional (3D) laser scanning technology. By using the surface wrap method, the configuration parameters of the large airship are calculated. According to the test data of the configuration, the structural dimensions such as the distances between the characteristic sections are measured. The method of the deformation analysis for the airship contains the algorithm of non-uniform rational B-splines (NURBS) and the finite element (FE) method. The algorithm of NURBS is used to obtain the reconfiguration model of the large airship. The seams are considered and the seam areas are divided. The FE model of the middle part of the large airship is established. The distributions of the stress and the strain for the large airship are obtained by the FE method. The position of the larger deformation for the airship is found.

Keywords: large airship, deformation analysis, three-dimensional (3D) laser scanning technology, non-uniform rational B-splines (NURBS), system engineering.

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1. Introduction

High-altitude aerostats have been increasingly developed in the direction of multi-functionality and large size. Due to the large size and the high flexibility of the large aerostats, new challenges have appeared in the configuration test and the deformation analysis. The configuration parameters of the large airship can provide important data for the flight experiments [1]. The location in which the larger airship deformation value is recorded, can be quickly found from the strain distribution. It is crucial for the safety of the inflatable structures. Cathey et al. [2–4] used the photogrammetry system to test the local configuration and the surface strain of the airship. The spatial coordinates of only few reflective points on the surface of the airship could be obtained. The overall configuration of the airship is predicted by the local configuration. Although the precision of the spatial coordinates for the reflective points is high, the number of the reflective points is small. This will produce the deviation when predicting the parameters of the overall configuration for the large airship. The test method of the configuration for the large airship takes long time and large workload. This method is inefficient. For the inflatable structures, National Aeronautics and Space Administration (NASA) [5] and Shen et al. [6] proposed a test method for the configuration of the airship by the three-dimensional (3D) digital laser scanning technology. It is an advantage because the 3D digital laser scanning technology can be used to quickly acquire large numbers of points for the airship surface.

Photogrammetry was used to test the surface strain of the airship, and the results indicated that the method was accurate and practical [3,4,7,8]. The deformation values were calculated by using the interpolation algorithm and the coordinate differences of the reflective points. However, only the strain data of the reflective points can be obtained. While the continuous full-field strain of the local surface for the airship cannot be obtained. At the same time, the 3D digital image correlation (DIC) technique was introduced to measure the surface strain of the inflatable structure [9]. And to obtain the full-field strain of its local area. In addition, the test method is very difficult for the large airship. A method that analyses the full-

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field strain of all surfaces for the large airship should be researched. The full-field strain of the large airship should be obtained to find the position of the larger deformation.

The methods of the configuration test and the deformation analysis for the large airship have been researched and discussed. Using the 3D laser scanning technology, a tested method of the configuration named internal scanning is established to quickly obtain the spatial information of all surfaces for the large airship. NASA [10] proposed a 3D laser scanning method for testing the configuration of the structure for the pressure reducer. However, no relevant applications have been seen for the large inflatable structures. By using the surface wrap method, the configuration parameters of the large airship are calculated. According to the test data of the configuration, the structural dimensions such as the distances between the characteristic sections are measured. The algorithm of non-uniform rational B-splines (NURBS) is used to obtain the reconfiguration model of the airship. The 3D data scanner is used to measure the point data of physical sample. The inverse reconstruction method is uesd to achieve the reverse modeling and error detection analysis of the digital model [11,12].

It is necessary to balance the efficiency and accuracy of the configuration test and deformation analysis for the large airship. The large airship is an inflatable structure. It cannot maintain its shape for a long time. The configuration and deformation test should be completed in a short time. It is difficult to test the deformation data in a short time with the current technology. Therefore, this article first proposes the internal scanning method, which can quickly scan the complete configuration data of the large airship in one-stop. It not only ensures the scanning efficiency, but also ensures the scanning accuracy. Using point cloud reverse reconstruction modeling and finite element (FE) method, the deformation analysis of the large airship is carried out. There is no need to test the deformation of the airship. The seams are considered and the seam areas are divided. The FE model of the middle part of the airship is established. And the FE method is used to analyze the deformation.

2. Configuration testing method of the large airship

2.1 Principle of 3D laser scanning

A typical process of the 3D digital laser scanning can be described by the principle of the laser ranging, as shown in Fig. 1. The horizontal and the vertical angles (α, β) are measured by the devices inside the laser scanner. The distance L between the difference of the emission and the recovery time for the pulsed laser is similarly measured by the devices inside the laser scanner. Point P is the target point on the surface of the measured object. Therefore, the space coordinates of the target point P are obtained by the distance L and the angles (α, β). X_POY_P is the plane, and Z_P is the vertical direction.

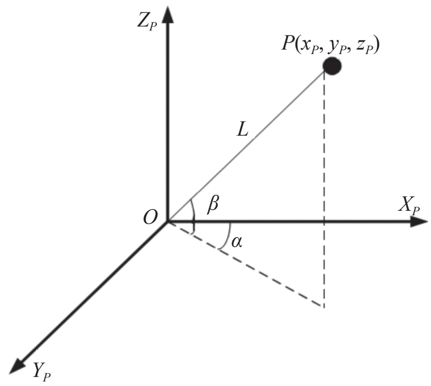


Fig. 1 Typical principle of process for 3D digital laser scanning

Complete surface of the measured object can be quickly scanned by the 3D digital laser scanner. A large number of the target points on the surface can be quickly obtained. It provides the possibility that the configuration of the large inflatable structures can be tested by the 3D digital laser scanning technology.

2.2 Configuration testing method

The research object for this paper is a large airship with 100 m of the length. The large size of the airship has made it difficult to test the configuration [13]. At the same time, the airship is a flexible inflatable structure, and its configuration is greatly affected by the internal pressure. Therefore, the configuration of the large airship requires high efficiency and reliability of the test method. If the digital photogrammetry technology is used for the large airship configuration test, countless targets must be pasted to the surface of the airship firstly. Ascending equipment is required when taking pictures, which greatly increases the cost and preparation time. At the same time, it is difficult to guarantee the feasibility. This method requires a long time to take pictures. It is difficult to maintain the shape in such a long time for the inflatable structure. Ascending equipment is required for the external laser scanner, which greatly increases the cost and scanning time. At the same time, there is a question of the feasibility. It can be seen from the principle of laser scanning that a large number of point data on the surface of the measured object can be obtained by the laser scanning method. The laser scanning method is applied to the configuration test of large airship combined with the characteristics of laser scanning. This paper proposes a test method of the configuration for the large airship, named internal scanning. It can quickly scan out the complete configuration data in one-stop for the internal laser scanning method. It not only guarantees the scanning efficiency, but also guarantees the scanning accuracy. The test method of the configuration for the large airship includes two aspects: one is the internal test, the other is the 3D laser scanning. The scanner is placed in the internal middle bottom of the large airship. Only one station is needed to quickly scan the space information of the inner surface for the large airship. The scanner is named Trimble TX5. The scanning accuracy of the scanner is 2 mm@25 m. It can be used to scan the space information of all surfaces for the airship. The time of a single configuration test is about 2 min. This method provides an important foundation for the accurate analysis of the configuration. Fig. 2 shows the schematic diagram of the internal scanning method of the configuration for the large airship. The characteristic sections of the large airship are marked as a, b, c, and d respectively. The part between the characteristic sections b and c is called the middle part of the airship. The part between the characteristic sections a and b is called the head part of the airship. The part between the characteristic sections c and d is called the tail part of the airship.

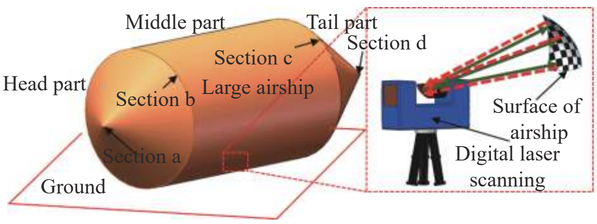
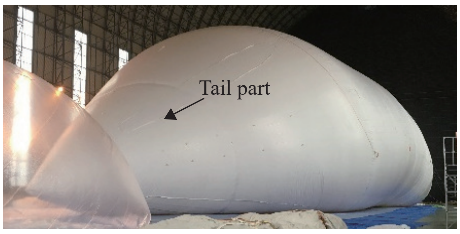


Fig. 2 Schematic diagram of the internal scanning method for the large airship

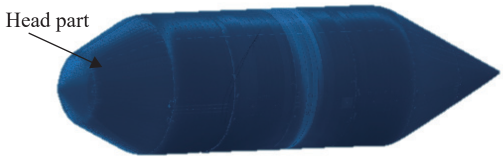
3. Analysis of configuration parameters of the large airship

The volume parameters provide the important data of the buoyancy during flight. These require accurate conclusions before the flight test of the airship.

Fig. 3 shows the test result of the configuration for the large airship. Fig. 3 contains the point cloud of the inner surface for the large airship. The point cloud is obtained by the internal scanning. The number of the points of the inner surface for the large airship is about 120 million in a single test. As can be seen from the point cloud, the surface information of all areas for the large airship can be obtained under one station. It is helpful to accurately analyze the configuration parameters for the large airship.



(a) Photo of the large airship



(b) Point cloud of the large airship (test result of configuration)

Fig. 3 Point cloud of the inner surface for the large airship

Therefore, by using the internal scanning method, the spatial information of all surfaces for the large airship can be quickly and effectively obtained.

The data of points for the configuration test of the airship is polygonised by the surface wrap method. The surface wrap method is based on the local triangulation to construct the global triangulation. The method of the global triangulation is to project the set of points onto the fitting plan. The 3D problem is transformed into a two-dimensional (2D) problem. The regular triangulation of plan is calculated. The regular triangulation is the generalization of the Delaunay triangulation, which is the triangulation of sets of weighted points. The weighted point refers to the general point plus the weight. The squared distance of the two weighted points is defined as (2D as an example):

$$d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2 - w_1 - w_2 \tag{1}$$

where x_1, x_2, y_1 and y_2 are the spatial coordinates of the points, w_1 and w_2 are the weights.

Fig. 4 shows the principle of local triangulation. The circumcircle of any triangle does not contain other points in the point set. The weight is the inverse of the squared distance from the point set to the plane. In the triangulation structure of the point set circle triangle of the point is actually constructed. Holes are formed when the model of the airship is polygonised. Combining the principle of uniform curvature, such holes can be filled. A global polygonal model of the large airship is formed. By calculating the configuration parameters of the polygonal model for the large airship, the volume and the surface area of the configuration parameters for the large airship can be obtained in different internal pressures. Fig. 5(a) shows the polygonal model of the large airship before the holes are filled. Fig. 5(b) shows the polygonal model of the large airship after the holes are filled.

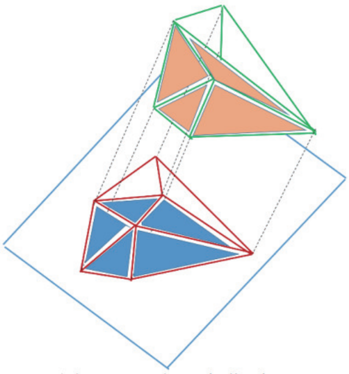
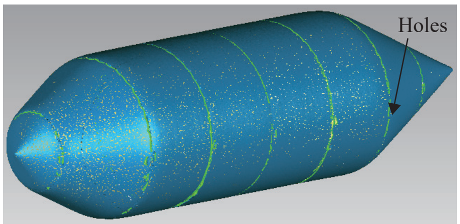
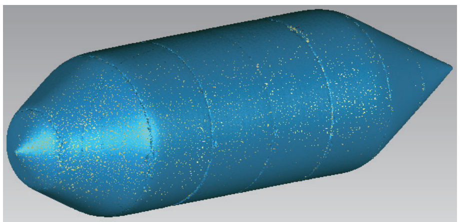


Fig. 4 Principle of local triangulation



(a) Before holes filling



(b) After holes filling

Fig. 5 Polygonal model of the large airship

Fig. 6 shows the values of the volume for the large airship for different internal pressures. Fig. 7 shows the values of the surface area for the large airship for different internal pressures. The abscissa is the internal pressure of the large airship, and the ordinates are the volume V_C and the surface area S_C of the large airship. The volume V_C is the product between the tested large airship volume and the coefficient C. The surface area S_C is the value of the product between the tested large airship surface area and the coefficient C. The coefficient C is a figure in the range 0.9 to 1. It can be seen that the values of the volume and the surface area of the large airship are almost linear with the internal pressures. The values of the volume and the surface area for the configuration parameters of the large airship can provide important data for the flight experiment. When the internal pressure is 300 Pa, the design value of the volume for the large airship is 61 793 m^3. The test value of the volume for the large airship is 61 790 m^3. The difference between the design and the test value of the volume is very small.

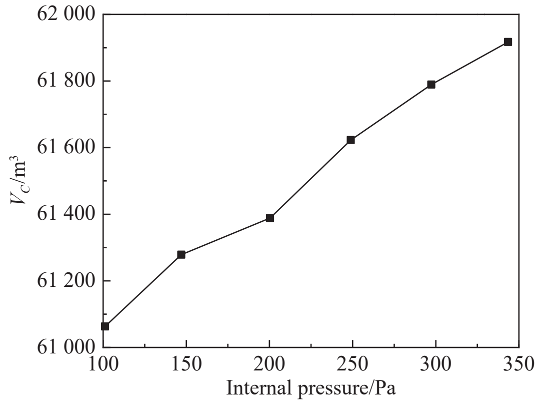


Fig. 6 Large airship volume

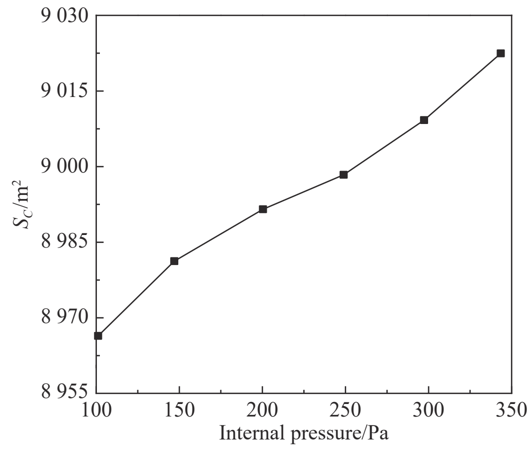


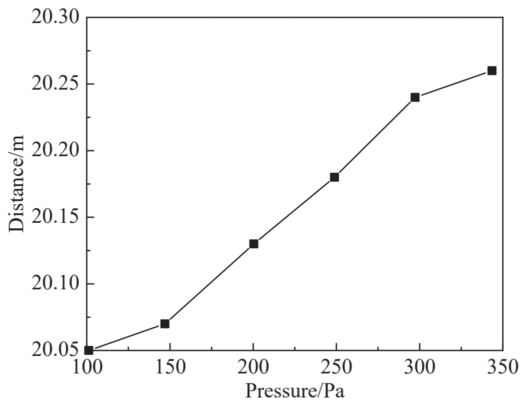
Fig. 7 Large airship surface area

The tested method of the configuration named internal scanning is established. It includes two aspects: one is the internal test, the other is the 3D laser scanning. Combined with the surface wrap method, configuration parameters of the large airship can be calculated. The volume parameters of the large airship are obtained. This provides important data for the buoyancy calculation of the large airship.

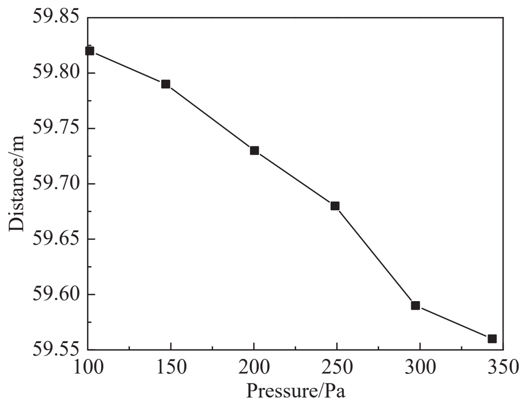
4. Analysis of the structural dimension for the large airship

The regularity of the structural dimensions provides the important data for the optimal design of the airship structure.

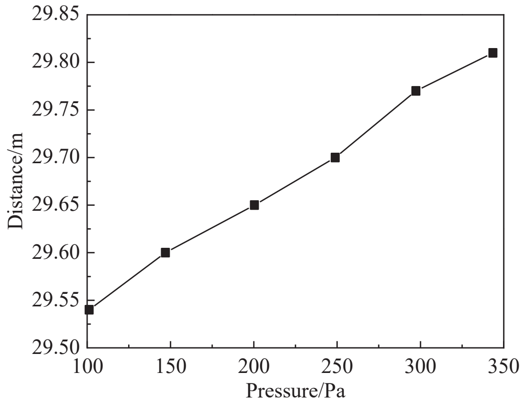
By measuring the distances between two points on the surface of the large airship, the distances between the characteristic sections of the large airship can be obtained for each internal pressure value. Fig. 8 shows the distance between the characteristic sections of the airship in different internal pressures. The abscissa is the internal pressure of the large airship, and the ordinates are the distances between the characteristic sections of the large airship. As can be seen from the values of the distances between the characteristic sections of the large airship, the distance between the sections b and c of the middle part for the large airship is reduced with the increase of the internal pressure. The distance between the sections a and b of the head part for the large airship is increased with the increase of internal pressure. The distance between the sections c and d of the tail part is increased with the increase of internal pressure as well. With the gradual increase of the internal pressure, the increase of the total length for the large airship gradually slows down under the unit internal pressure. These indicate that the deformation of the large airship is gradually turned on to the circumferential deformation. Therefore, by measuring the distances between the characteristic sections of the large airship, the relationships between the structure sizes and the internal pressures of the airship can be found. The regularity of the structural dimensions for the large airship can be obtained. This provides important data for the optimal design of the airship structure.



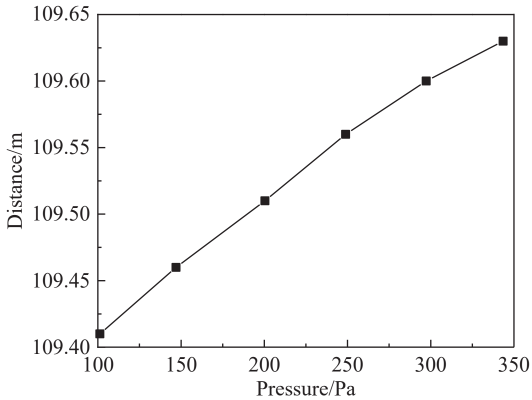
(a) Distance between the the sections a and b



(b) Distance between the the sections b and c



(c) Distance between the the sections c and d



(d) Distance between the the sections a and d

Fig. 8 Distances between the sections of the airship for different internal pressure values

5. Analysis method of the deformation for the large airship

The inflatable structures such as the airships present the manufacturing errors or the local structural defects in the manufacturing phase. This will cause the difference between the deformation of the inflatable structure and that of the ideal design structure. Therefore, it is necessary to research the method of the deformation analysis and the method of the deformation test. The position of the larger deformation for the inflatable structures should be found.

5.1 Method of reverse reconstruction modeling

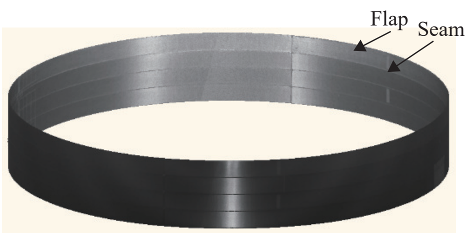
The algorithm of NURBS is used to construct the model of the surface for the airship. The points obtained by the configuration test of the airship are used. The inverse reconstruction model of the large airship is obtained. The NURBS surface is a non-uniform and powerful B-spline bi-parametric surface. It is uniquely determined by the node vector, the control grid point, and the weight. A region in 2D space is mapped to a surface in 3D space [14−16]. The equation of the NURBS surface is described as

$$S(u,v)=\frac{\sum_{i=0}^{C_u}\sum_{j=0}^{C_v}W_{i,j}P_{i,j}N_{i,p}(u)N_{j,q}(v)}{\sum_{i=0}^{C_u}\sum_{j=0}^{C_v}W_{i,j}N_{i,p}(u)N_{j,q}(v)} \tag{2}$$

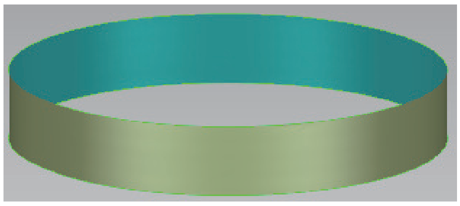
where C_u and C_v are the number of points in the u and v direction respectively, $P_{i,j}$ (i=0, 1, $\cdots$, C_u; j=0, 1 ,$\cdots$, C_v) is the control vertex array, $W_{i,j}$ is the weight, $N_{i,p}(u)$ (i=0, 1, $\cdots$, C_u) is the p-order B-spline function in the u direction, and $N_{j,q}(v)$ (j=0, 1 ,$\cdots$, C_v) is the q-order B-spline function in the v direction. They are respectively determined by the node vectors $\boldsymbol{U}$ (u_0, u_1, $\cdots$, u_{Cu+p+1}) and $\boldsymbol{V}$ (v_0, v_1, $\cdots$, v_{Cv+q+1}) in the u-direction and v-direction according to the De Boor recurrence formula. Taking the spline base in the u direction as an example, its De Boor recurrence formula is described as

$$\begin{cases}N_{i,0}(u)=\begin{cases}1, & u_i\leqslant u_{i+1}\\ 0, & \text{otherwise}\end{cases}\\ N_{i,p}(u)=\dfrac{u-u_i}{u_{i+p}-u_i}N_{i,p-1}(u)+\dfrac{u_{i+p+1}-u}{u_{i+p+1}-u_{i+1}}N_{i+1,p-1}(u)\end{cases}. \tag{3}$$

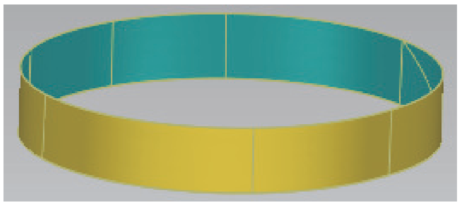
The deformation of the middle part for the large airship is analyzed in this paper. The structure of the large airship is unstable at low internal pressure. The test data of the configuration of the large airship under 250 Pa internal pressure is selected. The test data of the configuration is used to analyze the deformation of the large airship. Firstly, the point data of the middle part of the airship are separately intercepted. The surface wrap method and the algorithm of NURBS are used to inversely reconstruct the intercepted part of the large airship. The inverse reconstruction model of the middle part for the large airship is obtained. At the same time, the seams of the large airship are considered. In order to simulate the real structure of the middle part of the airship as much as possible, the seam areas are divided according to their real size and position. The areas of the flaps and the seams of the inverse reconstruction model for the airship are distinguished. Fig. 9 shows the schematic diagram of the process of the reverse reconstruction for the middle part of the large airship.



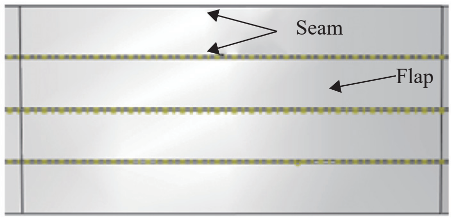
(a) Points interception



(b) Surface wrap



(c) NURBS surface



(d) Seam area division

Fig. 9 Schematic diagram of the process of the reverse reconstruction for the middle part of the large airship

5.2 FE method

The FE method is used to analyze the deformation of the inverse reconstruction model of the airship. The large airship is inflatable structure. The large airship is flexible. The contact test of the traditional method is not applicable. The non-contact digital image processing method can be used to measure a small area of the large airship. This requires multiple tests. At the same time, there are some problems in the feasibility. The large airship cannot rotate freely. The time and the cost are greatly increased. It also needs some auxiliary equipment. The FE model of the airship is established by the reconstruction model. The FE software ABAQUS is used. The reconstruction model of the large airship is simulated by the large deformation FE method. The FE method is the total Lagrangian description (TLD).

The virtual work equation of time t is described as

$$\int_V\left(\delta\{\boldsymbol{\varepsilon}^t\}^{\mathrm{T}}\{\boldsymbol{s}^t\}-\delta\{\boldsymbol{u}^t\}^{\mathrm{T}}\{\boldsymbol{b}^t\}\right)\mathrm{d}V^{(0)}-\int_{S_\sigma}\delta\{\boldsymbol{u}^t\}^{\mathrm{T}}\{\boldsymbol{t}_e^t\}\mathrm{d}S^{(0)}-\delta\{\boldsymbol{u}^t\}^{\mathrm{T}}\{\boldsymbol{P}^t\}=0. \tag{4}$$

where $\boldsymbol{u}^t,\boldsymbol{s}^t,\boldsymbol{\varepsilon}^t,\boldsymbol{b}^t,\boldsymbol{t}_e^t$ and $\boldsymbol{P}^t$ are displacement, stress, strain, body force, surface force and concentrated force vector matrices at time t, respectively. δ is the variational sign. V is the volume. S_σ is the unit area.

$$\int_V \left(\delta\left\{\boldsymbol{\varepsilon}^{t+\Delta t}\right\}^{\mathrm{T}}\left\{\boldsymbol{s}^{t+\Delta t}\right\}-\delta\left\{\boldsymbol{u}^{t+\Delta t}\right\}^{\mathrm{T}}\left\{\boldsymbol{b}^{t+\Delta t}\right\}\right)\mathrm{d}V^{(0)}- \int_{S_\sigma}\delta\left\{\boldsymbol{u}^{t+\Delta t}\right\}^{\mathrm{T}}\left\{\boldsymbol{t}_\varepsilon^{t+\Delta t}\right\}\mathrm{d}S^{(0)}-\delta\left\{\boldsymbol{u}^{t+\Delta t}\right\}^{\mathrm{T}}\left\{\boldsymbol{P}^{t+\Delta t}\right\}=0. \quad (5)$$

The incremental virtual work equation is obtained by subtracting (4) and (5), which is described as

$$\int_V \left[\delta\{\Delta\boldsymbol{\varepsilon}\}^{\mathrm{T}}\{\Delta\boldsymbol{s}\}+\delta\{\Delta\boldsymbol{\eta}\}^{\mathrm{T}}\{\boldsymbol{s}\}-\delta\{\Delta\boldsymbol{u}\}^{\mathrm{T}}\{\Delta\boldsymbol{b}\}+ \delta\{\Delta\boldsymbol{\varepsilon}\}^{\mathrm{T}}\{\boldsymbol{s}\}-\delta\{\Delta\boldsymbol{u}\}^{\mathrm{T}}\{\boldsymbol{b}\}\right]\mathrm{d}V^{(0)}- \int_{S_\sigma}\delta\{\Delta\boldsymbol{u}\}^{\mathrm{T}}\{\boldsymbol{t}_e+\Delta\boldsymbol{t}_e\}\mathrm{d}S^{(0)}-\delta\{\Delta\boldsymbol{u}\}^{\mathrm{T}}\{\boldsymbol{P}+\Delta\boldsymbol{P}\}=0 \quad (6)$$

where $\boldsymbol{\eta}$ is the elongation vector matrix.

$$[K(S_{IJ}^t)]\{\Delta\boldsymbol{u}\}=\{\Delta F(S_{IJ}^t)\} \quad (7)$$

where S_{IJ} is the Kirchhoff stress, K is the stiffness, and F is the load.

The distributions of stress and strain in the middle part of the airship can be obtained. The parameters of the skin material for the large airship are obtained by the uniaxial tensile test along the warp and weft directions, as reported in Table 1.

Table 1 Skin material parameters of the airship

Parameter	Value
Elastic modulus/GPa	10
Poisson's ratio	0.3
Thickness(flap)/mm	0.2
Thickness(seam)/mm	0.4

The material is the Vectran fabric skin material. The reference standard for the tensile test is GB/T 3923.1-2013. The size of the skin material sample is 50×200 mm. The thickness of the seam area is twice of the flap area. The FE model of the middle part of the large airship is meshed by the shell units. The loads of the internal pressure are applied to the surface of the FE model of the middle part for the large airship, which are 100 Pa and 200 Pa respectively. The cylindrical coordinate O-RTZ is established. The Z-direction is along the axis-direction of the FE model. The cylindrical coordinate is shown in Fig. 10. The corner and the displacement constraints are applied at the edges of the FE model. The edges of the FE model are edge B_1 and edge B_2, respectively. Edges B_1 and B_2 are shown in Fig. 10. The displacements at the edges B_1 and B_2 of the FE model are limited along the T direction, which are zero of the displacement values. The corners at the edges B_1 and B_2 of the FE model are limited along the R, T and Z directions, which are zero of the corner values. Fig. 10 shows the FE model of the middle part of the large airship, which includes the load and boundary constraints.

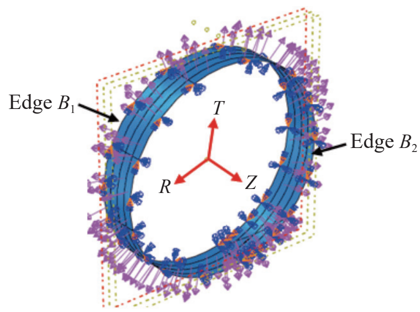


Fig. 10 FE model of the middle part of the large airship

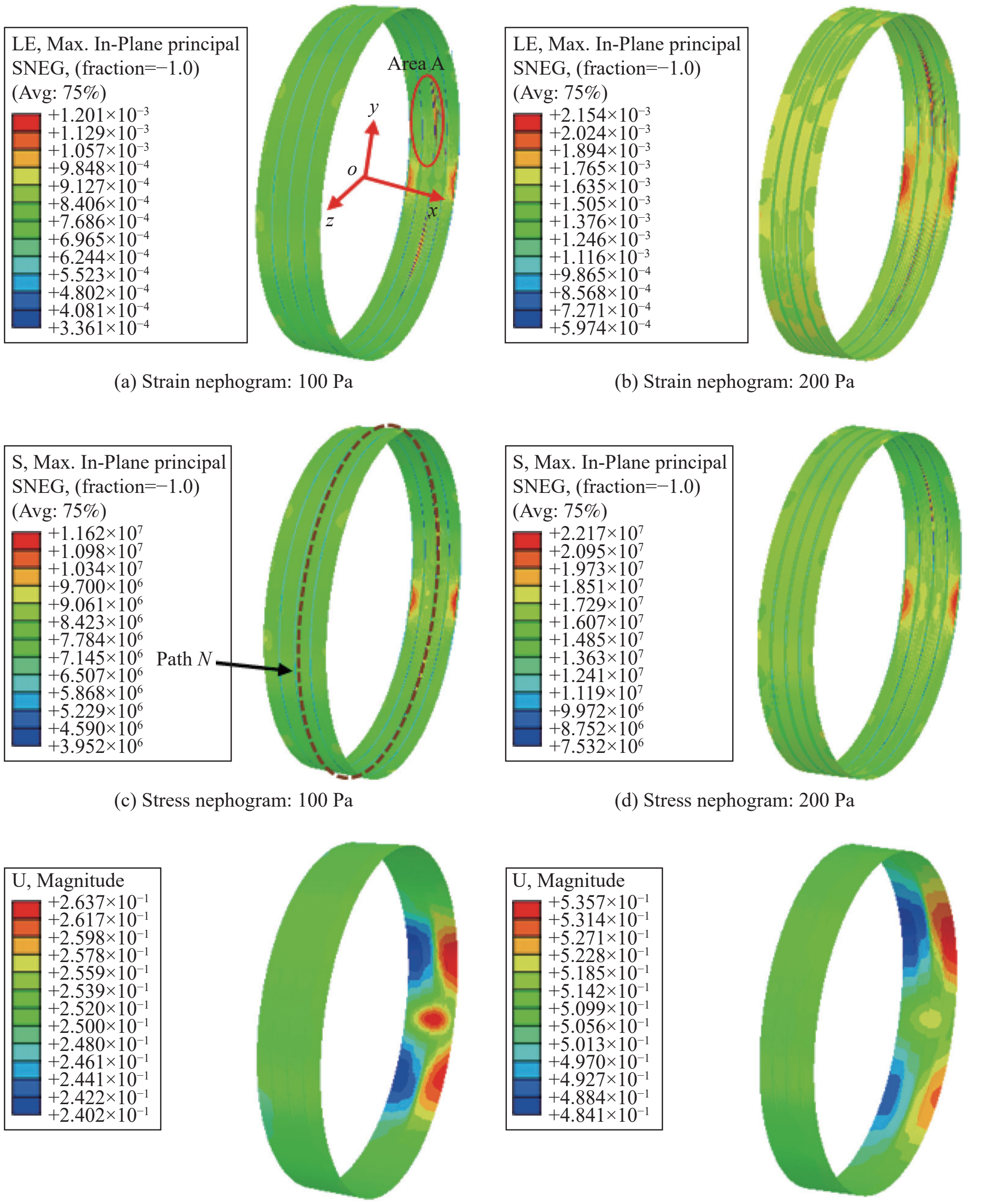
5.3 Deformation analysis

Fig. 11 shows the strain, the stress, and the displacement nephograms of the FE model for the middle part of the large airship. It can be seen that the values of the stress, the strain and the displacement of the area A are larger than the values of the other areas. The area A is shown in Fig. 11(a). The spatial coordinate system o-xyz of the FE model for the middle part of the airship is also established. The spatial coordinate system o-xyz is shown in Fig. 11(a). A path named N is divided in the FE model of the large airship. The path N is shown in Fig. 11(c). The values of the stress and the strain are analyzed along the path N. The path N is located in the middle of the single flap for the FE model.

Fig. 12 shows the stress and the strain curves of the FE model along the path N. It can be seen that the values of the stress and the strain in the area A is obviously larger than that in other areas, which is about 13% larger. At the same time, the extreme values of the stress and the strain appear.

These show that the values of the stress and the strain for the area A is larger under the same internal pressure. The area A of the airship is relatively dangerous. The area A of the airship is more likely to be destroyed. This may be caused by the manufacturing errors or the local structural defects of the airship. The area A of the airship should be needed to focus on the larger deformation.

For the error analysis of the results, we use the design data and FE results to check the test results. We compare the difference between the FE analysis results and the design results. We find that the volume increase under unit internal pressure is basically the same between the FE analysis results and the design results.



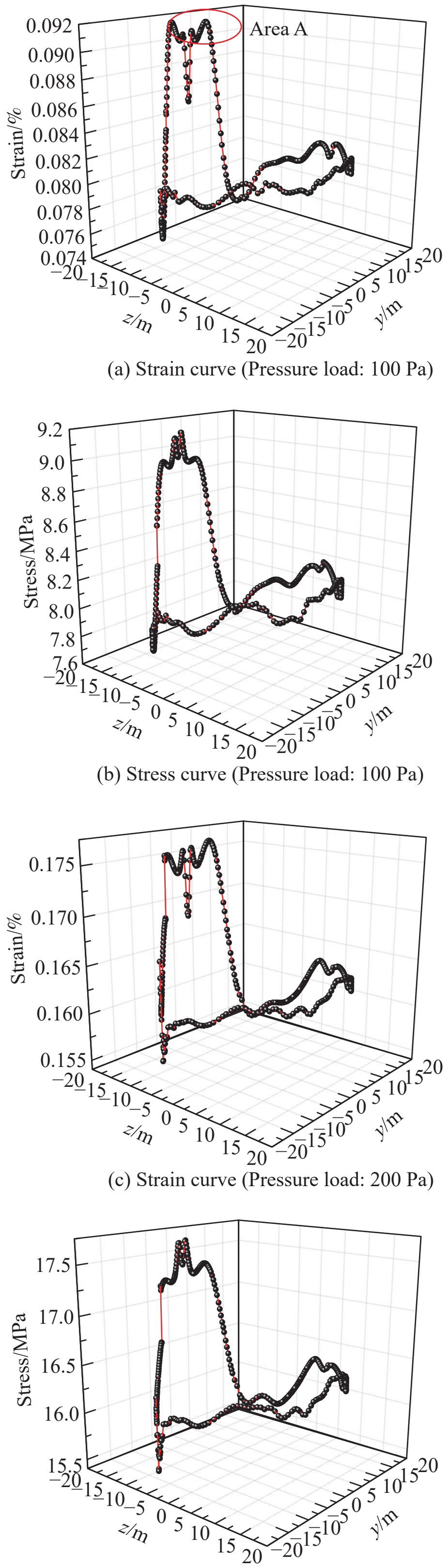
(a) Strain nephogram: 100 Pa (b) Strain nephogram: 200 Pa

(c) Stress nephogram: 100 Pa (d) Stress nephogram: 200 Pa

(e) Displacement nephogram: 100 Pa (f) Displacement nephogram: 200 Pa

Fig. 11 The strain, the stress, and the displacement nephograms of the FE model for the middle part of the airship

Therefore, the analysis method of the stress and the strain for the large airship is proposed. The distributions of the stress and the strain can be obtained by the analysis method. The analysis method of the stress and the strain for the large airship includes two aspects: one is the algorithm of NURBS, the other is the FE method. The FE model of the airship is obtained by the surface wrap method and the algorithm of NURBS. Using the FE method, the distributions of the stress and the strain for the airship are obtained. At the same time, the position of the larger deformation for the airship can be quickly found. This is crucial for the safety of airship. The internal scanning method can quickly scan the complete configuration data of the large airship in one stop. There is no need to splice the scanned data. It not only ensures the scanning efficiency, but also ensures the scanning accuracy. Based on the accurate scanning data, the accurate FE model of large airship can be constructed by using the reverse reconstruction modeling method. Therefore, the FE simulation results can be effectively guaranteed. More verification of the current test method will be considered for the future test tasks.



(a) Strain curve (Pressure load: 100 Pa)

(b) Stress curve (Pressure load: 100 Pa)

(c) Strain curve (Pressure load: 200 Pa)

(d) Stress curve (Pressure load: 200 Pa)

Fig. 12 Stress and strain curves of the FE model for the middle part of the airship

6. Conclusions

The methods of the configuration test and the deformation analysis for the large airship are researched and discussed. The methods are suitable for inflatable structures. The accurate parameters of the configuration for the large airship are quickly obtained. And the distributions of the stress and the strain are obtained. The position of the larger deformation for the airship is found. It is crucial for the safety of these inflatable structures.

The configuration test method named internal scanning for the large airship is established. It includes two aspects: one is the internal test, the other one is the 3D laser scanning. Combined with the surface wrap method, the configuration parameters of the large airship can be calculated. By measuring the distances between the characteristic sections of the large airship, the relationships between the structure sizes and the internal pressures for the airship can be found.

The acquisition method of the stress and the strain distributions for the large airship is proposed. It includes two aspects: one is the NURBS algorithm, the other one is the FE method. The FE model (reconstruction model) of the airship is obtained by the surface wrap method and the NURBS algorithm. Using the FE method, the distributions of the stress and the strain for the airship are obtained. The position of the larger deformation for the airship can be quickly found.

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