Analysis and Research on Defrosting Ventilation Pipe Deformation of Automobile

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Abstract: According to the market feedback, automobile defrosting ventilation pipe does not fit in the top 10 of xiangtan geely automobile market quality problems. According to the detection of vehicles in this condition, the reason for the deformation of automobile defrosting ventilation pipe position is that the gap between instrument cover and ventilation pipe is less than 4mm. Ventilation tube ends around not level off, the present state of collapse, and the intensity of this state collapse is due to the lack of overall deformation, for deformation reasons of automobile ventilation pipe outlet increase 11 on the back of the improved design scheme of reinforcement, using the method of three-dimensional modeling, design parameters, according to auto defrost ventilation tube through the Pro/E 3 d software to complete the ventilation pipe before and after the improvement model, using ANSYS Workbench software of finite element analysis was carried out on the ventilation pipe before and after improvement, the maximum deformation analysis ventilation pipe outlet, After the improvement, the deformation amount decreased from 10.643mm to 10.283mm, and the maximum stress value of the ventilation pipe decreased from 85.783MPa to 55.781MPa, less than the ultimate strength of 70MPa, verifying the rationality of the improved design, Solve the quality problem for the enterprise, have very good reference value.

1 INTRODUCTION

According to the feedback from the market, the defrosting ventilation pipe on the instrument table is deformed, which affects the product quality and brand image of the vehicle. Therefore, the elimination of defrosting defrosting ventilation pipe on the instrument has become an improvement object. According to statistics: in January 2018, the problem of unconformity of automobile defrosting ventilation pipe was ranked among the top 10 in the market, so the project was immediately started to solve the problem of automobile. In the old parts collection list, 200 vehicles of a certain model found deformation of defrosting outlet position on the instrument, as shown in figure 1:

Defrosting system (Tang Zhiliang, 2014) is an important function to ensure the safe driving of drivers in low temperature environment. Common failure modes of automobile defrosting system include no air supply, uneven air output, deformation of ventilation pipes and pipelines, and poor sealing of pipelines. Poor defrosting performance reduces user experience and affects driving vision, and serious defrosting will lead to safety accidents. Therefore, as an important functional part of an automobile, its quality needs to be strictly controlled in the design stage and manufacturing process.

In the stage of automobile design, the body accessories will be rigorously verified. However, in the manufacturing process, there are often unqualified parts provided by suppliers, or improper matching problems that cannot be found in the actual assembly process. In this paper, we study the defrosting export position ventilation tube deformation is one of the common problems, in order to solve the fault, eliminate defrost is not completely safe hidden trouble, should be according to the failure situation, analysis question reason, make the corresponding improvement measures, improve the quality of automobile products and

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brand image, effectively improve the safety of driving, to better protect the safety of members.

Figure 1. Defrosting ventilation pipe on instrument is deformed.

2 CAUSE ANALYSIS OF DEFROSTING VENTILATION PIPE POSITION DEFORMATION

2.1 Automobile Defrosting Ventilation Pipe Deformation Phenomenon

Automobile defrosting ventilation pipe deformation phenomenon: defrosting ventilation pipe on the instrument cover deformation occurred in the matching position and the collapse deformation of the left and right ends of the ventilation pipe.

(1) The defrosting ventilation pipe on the instrument is deformed in the matching position: 1) there is a large gap between the upper cover and the ventilation pipe at the defrosting ventilation pipe on the instrument; 2) defrosting ventilation pipe on the meter is deformed.

(2) Collapse and deformation of the left and right ends of the ventilation pipe

Phenomenon: there is a large gap between the overlap position of the ventilation pipe and the upper cover of the instrument, the maximum gap has reached 10mm, and the left and right ends of the ventilation pipe are obviously collapsed and deformed.

2.2 The Cause of Defrosting Ventilation Pipe Deformation of Automobile

(1) In order to find out the deformation reasons of automobile defrosting ventilation pipe, the following results are obtained through on-site disassembly analysis:

1) Vehicle status and temperature related, the noon gap is greater than the morning gap;

2) Cutting instrument table cover, instrument table cover and ventilation pipe without interference;

3) Separate instrument table high temperature test, qualified products, not deformation.

(2) According to the fault phenomenon of the vehicle, the 4M method is used to analyze the cause of ventilation pipe deformation.

4M method (Wangjiansong, 2018), also known as 4M inspection method, is also known as "man-machine-material-method" analysis method, which is one of the tools to judge the causes of problems and formulate solutions. The gap between the instrument cover and the ventilation pipe is less than 4mm. The left and right ends of the ventilation pipe are not flat, showing collapse state. And this collapse state is caused by insufficient strength, according to this main line, measures can be formulated.

2.3 Automobile Defrosting Ventilation Pipe Improvement Scheme

In order to meet the strength requirements of the ventilation pipe, two measures are generally adopted: (1) increase the basic thickness of the ventilation pipe; (2) increase the number and layout of the stiffeners.

According to the information of the ventilation pipe, the ventilation pipe can improve its strength by increasing its thickness. However, considering the cost, if the basic thickness of the ventilation pipe is increased to improve the strength, the material cost will increase.

Although the contribution effect of reinforcing rib to the improvement of structural strength is not great, the strength of ventilation pipe is enhanced without increasing the wall thickness of ventilation pipe, so as to save material consumption, reduce weight and reduce cost. It can overcome the collapse of ventilation pipe caused by the uneven stress caused by the difference of wall thickness.

PP material (Songke, 2015) is a kind of material in injection molding. In order to ensure the strength of the ventilation pipe without causing the wall of the ventilation pipe to thicken, reinforcing ribs are set on the back of the ventilation pipe, which can not only avoid the deformation of the ventilation pipe, but also improve the flow of the ventilation pipe under certain circumstances. In order to increase the strength of the ventilation pipe, it is preferred to increase the number of stiffeners rather than the wall thickness.

Therefore, this paper uses reinforcing bars to add 11 reinforcing bars on the back of the air outlet of the automobile ventilation duct.

3 STRUCTURE ANALYSIS AND IMPROVEMENT DESIGN MODELING OF AUTOMOBILE DEFROSTING VENTILATION PIPE

3.1 Ventilation Pipe Parametric Modeling Process

(1) Ventilation duct grille

In order to ensure that the air velocity at the outlet of the grille meets the requirements, the grille blade width of the ventilation duct is generally 1.5-3mm. The spacing between grid blades is generally 10-25mm, and the thickness of grid blades is no more than 2mm, so the width of blades is 3mm, the spacing between blades is 20mm, and the thickness of blades is 2mm.

(2) Selection of contour size of ventilation pipe

Minimum size of ventilation tube inlet width: 25mm; Then the width is 75mm. Generally speaking, the length size of the air inlet of the ventilation pipe is 350-400mm. Take it as 400mm, and the width of the air outlet of the ventilation pipe is 15-25mm. Then the width is 25mm; the air outlet length of the ventilation pipe is equal to the grille length of 550-850mm, which is 600mm.

(3) Radius of rounded corners of the ventilation pipe

The minimum fillet radius of the ventilation pipe is 8mm, as shown in figure 2.

(4) Angle on both sides of ventilation pipe

The Angle on both sides of the ventilation pipe should not exceed 60°, in order to reduce airflow loss, as shown in figure 3.

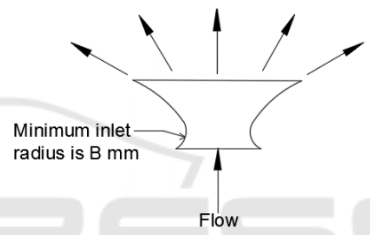

Figure 2. Minimum rounded radius of ventilation pipe.

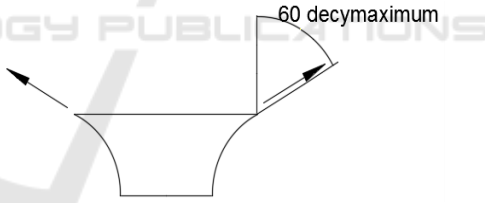

Figure 3. Angle of both sides of ventilation pipe.

(5) Left and right ventilation pipes

The left and right ventilation ducts are located at the lower end of the outlet of the main ventilation ducts. The diameter of the left and right ventilation ducts is 27mm.

(6) Chamfering of ventilation pipe

When designing chamfering, the wall thickness of the parts shall be uniform and uniform, and the chamfering design shall be 3.2mm. The main size data of ventilation pipe are shown in table 1.

Table 1. Main size data of ventilation pipe (unit: mm).

Outlet width	Outlet length	Inlet width	Inlet length	Ventilation height	Ventilation pipe thickness
25	600	75	400	80	2

3d software Pro/E was used to establish the model before and after improvement of the ventilation pipe, as shown in FIG.4 and FIG. 5.

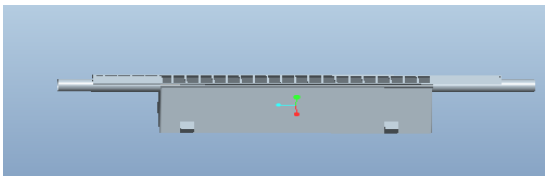

Figure 4. Before improvement of ventilation model.

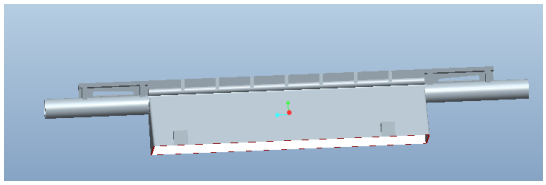

Figure 5. Improved ventilation model.

4 COMPARATIVE ANALYSIS OF FINITE ELEMENT STRUCTURE BEFORE AND AFTER VENTILATION PIPE IMPROVEMENT

The material properties of the ventilation pipe finite element model are shown in table 2.

Table 2. Ventilation pipe material properties.

elasticity modulus (N/mm2)	poisson ratio	density (kg/m^3)	load (N)	ultimate strength (MPa)
1300	0.39	910	1500	70

Reinforcing bars were added to the ventilation pipe. Finite element analysis was carried out before and after the ventilation pipe was improved by ANSYS Workbench, and the deformation amount and stress cloud diagram were obtained as shown in figure 6, 7, 8 and 9 respectively.

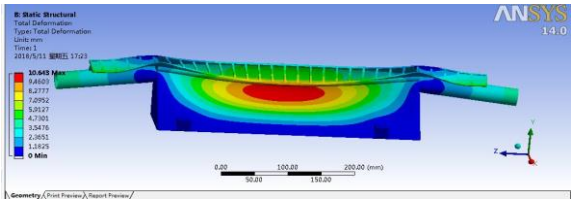

Figure 6. Deformation of ventilation pipe before improvement.

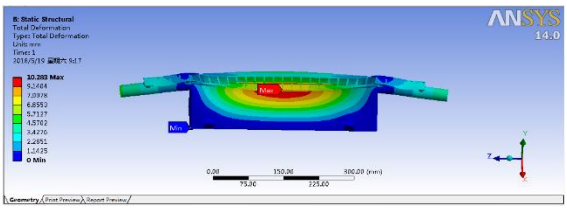

Figure 7. Deformation of ventilation pipe after improvement.

By observing the deformation amount of ventilation pipe in FIG. 6 and 7, it can be seen that the maximum deformation amount of ventilation pipe before improvement in FIG. 6 is 10.643mm. The ventilation pipe was reinforced, and the improved deformation was reduced from 10.643mm to 10.283mm.

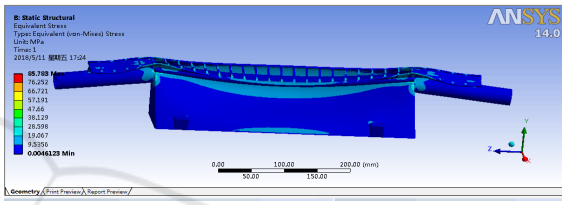

Figure 8. Before improvement of ventilation pipe stress.

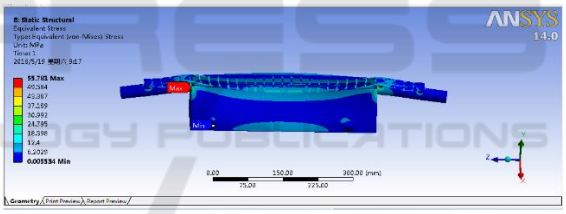

Figure 9. Improved ventilation pipe stress.

By observing FIG. 8 and 9 strain diagram of ventilation pipe, it can be seen that the maximum stress value of the ventilation pipe before improvement in FIG. 6 is 85.783mpa, which is greater than the ultimate strength of 70MPa, and fails to meet the requirements of ventilation pipe strength. The maximum stress value of the ventilation pipe after the reinforcement was added was 55.781MPa, less than 70MPa, which met the strength requirements of the ventilation pipe.

In summary, the deformation and stress values of the ventilation pipe before and after improvement are shown in table 3. It can be known from the table that the maximum stress value of the ventilation pipe before improvement is 85.783MPa, greater than the ultimate strength of 70MPa, and the maximum stress value of the ventilation pipe after improvement is 55.781MPa, less than the ultimate strength of 70MPa, meeting the strength requirements. The

Table 3. Ventilation pipe material properties.

Load(N)	Deformation (mm)		Stress value(MPa)	
	before improvement	improved	before improvement	improved
1500	10.643	10.283	85.783	55.781
1500	9.4603	9.1404	76.252	49.584
1500	8.2777	7.9978	66.721	43.387
1500	7.0952	6.8553	57.191	37.189
1500	5.9127	5.7127	47.660	30.992
1500	4.7301	4.5702	38.129	24.795
1500	3.5476	3.4276	28.598	18.598
1500	2.3651	2.2851	19.067	12.400
1500	1.1825	1.1425	9.5356	6.2029

comparison of ventilation before and after improvement shows that it is feasible to add reinforcing bars to the ventilation pipe.

5 SUMMARY

This paper is mainly based on the automobile defrosting ventilation pipe does not fit seriously affect the automobile brand and driving safety, find out the defrosting ventilation pipe position deformation reason, according to the deformation reason to put forward the improvement plan of adding reinforcement on the back of the ventilation pipe. By using Pro/E software on car ventilation tube before and after improvement, 3 d modeling, using ANSYS Workbench software model for finite element analysis before and after improvement of ventilation tubes, through the comparison and analysis to verify the ventilation pipe add reinforcement on the back of the rationality of the improved scheme, the auto defrost ventilation pipe has certain reference significance, optimal design to improve design quality, reduce design cost and shorten the development cycle, has good practical significance.

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REFERENCES

Tang Zhiliang. Research on defusing performance of automobile windshield frost fog [D]. Hunan University, 2014.

Wangjiansong. Research on the Measurement and Estimation of Gravity Vertical Line Deviation [D]. Southeast University, 2018.

Songke. Study on fatigue damage properties of PP materials [D]. Kunming University of Technology, 2015.