Analysis and Research on the Fault Phenomenon of Car Sunroof

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Abstract: Car skylight in view of the after-sales returns, customer site failure problem analysis, found abnormal closed, out of sync, sound and sealing strip fracture phenomenon, put forward by means of structural optimization and process optimization improvement scheme, according to the design parameters of automobile skylight components, through the corresponding module of 3 d software to complete the mechanical group of 3 d model before and after improvement. The rationality of the improved mechanical group was verified through experiments, and the fracture of seal strip was emphatically analyzed to verify the rationality of the improved scheme

1 INTRODUCTION

According to the data, the earliest sunroof appeared in the early 1930s. In 1937, Nash automobile company added the configuration of sunroof glass to some of its models, which is considered to be the earliest sunroof model in the automobile industry (Lu qiang, 2011). After that, there was a boom, and then there were sunroofs. With the development of economy, people's living standard is gradually improving. Cars have entered every family and can be seen everywhere in daily life. As a convenient device for ventilation when driving, car sunroof has gradually become the standard configuration of cars produced by automobile manufacturers, mainly installed in commercial SUV, car and other models. As one of the important configurations of automobiles, sunroof occupies a large proportion in today's automobile market, so it has higher requirements on the structural functions of sunroof (Chen jian, 2017). The sunroof is installed on the roof of the car, which can effectively circulate the air inside the car and increase the access of fresh air. At the same time, the car window also has the function of beautifying decoration, broadening the view and increasing the fun of driving. In addition, with the rapid development of automobile electronization and intelligentization, automobile sunroof has been developed from simple mechanization to high-tech products integrating electronics, optics, material science, photovoltaic energy and other technologies (Zhang zhimin, et.al, 2013).

Table 1 is the sunroof fault arrangement collected by xiangtan geely automobile after-sales service department. The fault complaint rate of the skylight is also increasing day by day. The skylight problem needs to be urgently repaired and solved. We need to collect the parts of the skylight that have problems in the after-sales market to find out the problems through material analysis, improve product

Table 1. Fault arrangement of certain type of skylight.

Failure mode	Skylight sound	Sealing strip extrusion	Skylight leaking	Seal strip broken	motor no work intermittently	other
number	20	15	10	5	2	1
percentage	37.74%	28.30%	18.87%	9.43%	3.77%	1.89%
combined	37.74%	66.04%	84.91%	94.34%	98.11%	100.00%

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quality and production process, and improve the reputation of the enterprise among consumers.

2 FAULT STUDY OF SKYLIGHT

According to the evidence and object analysis of the old parts returned from after-sales service and produced by the customer on site, it is found that in the same state, the proportion of defects of the skylight is: 90% of the deformation of the soft shaft and 10% of the fracture of the seal strip. Therefore, the following failure mechanism to do the key solution.

2.1 Failure Point 1 Study

According to the material analysis, it can be determined that the reason is the friction between the soft shaft and the bottom of the front beam caused by deformation and pressure. As a result, the soft shaft can't be fully integrated with the gear when it turns to the gear, and the car sunroof can't be closed normally after a long period of rotation, which is not synchronous and abnormal sound. Analyze the reasons for the failure: failure to comply with the inspection standards, problems in the production process of workers, unreasonable structure of product design.

With digital multimeter and electronic tension meter to the structure of physical test, on the soft shaft collected old and without the use of soft shaft bending resistance numerical tests before and after comparison, table 2, it can be seen without bending soft shaft new pieces after bending resistance than soft shaft after bending to an old piece of resistance value, so that the soft shaft deformation resistance is too large, need to review the complete product structure.

2.2 Failure Point 2 Study

The analysis of the failure parts can determine that the reasons are the insufficient strength of the broken seal strip and the short length of the seal strip design. The reasons for the failure are analyzed: the upper and lower mold temperature and vulcanization standard do not meet, the length of the sealing strip is not consistent.

During the test, the maximum tensile stress of the sealing strip to be tested depends on the production standard of the enterprise. The higher the tensile stress that the interface strength can withstand, the better the quality produced. Moreover, the test temperature and vulcanization time data of upper and lower mold used in the production and test of seal strip are also obtained from the production site.

Table 2. Fault arrangement of certain type of skylight.

number	current	Resistance after bending	Survey of current	Unbent post-bending resistance
1	5.7A	160N	4.0A	71N
2	5.5A	155N	3.8A	65N
3	5.94A	150N	3.9A	83N
4	6.45A	200N	4.2A	78N
5	5.62A	163N	4.1A	68N

Table 3. Interface tensile strength tracking record (before improvement).

Process conditions	Measurement value of 1	Measurement value of 2	Measurement value of 3	Measurement value of 4
upper module 245 degrees/ lower module 270 degrees Curing time	Constant value			
24S	95	98	98	101
28S	116	115	118	114
32S	108	111	109	113
36S	Wrinkled surface, unqualified appearance			

Table 4. Interface tensile strength tracking record (after improvement).

Process conditions	Measurement value of 1	Measurement value of 2	Measurement value of 3	Measurement value of 4
upper module 230 degrees/ lower module 260 degrees Curing time	Adjust the upper and lower die temperature for measurement			
28S	97	96	98	100
32S	128	125	127	130
36S	114	115	110	116
40S	Wrinkled surface, unqualified appearance			

After the condition test, the interface tensile strength was compared before and after improvement, and the production process was optimized and improved. Before improvement, when the temperature of the upper and lower molds is fixed, the curing time reaches 28 seconds, and the tensile strength of the sealing strip interface is the largest, as shown in table 3. After improvement, lower the upper and lower mold temperature by 10 degrees, and it will be found that when the curing temperature reaches 32 seconds, the tensile strength of seal strip interface reaches the best state, as shown in table 4.

Then, the length of sealing strip of the skylights of two models is compared. The measured length standard of sealing strip of the skylights of taizhou hongyun automobile is shown in table 5. The length standard of seal strip measured for a certain brand is shown in table 6. It is also necessary to reverify the sealing strip length.

Table 5. Taizhou hongyun brand seal strip length standard.

location	PU glass length (measured)	Standard length of sealing strip	Difference lower tolerance
upper	2488mm	2460±4mm	-20mm
rabbet	2465mm	2460±4mm	5mm
bottom	2482mm	2460±4mm	-12mm

Table 6. Standard length of seal strip of a certain brand.

location	PU glass length (measured)	Standard length of sealing strip (before)	(after)	Tolerance under difference (before)	Tolerance under difference value (after)
upper	2456mm			-30mm	-22mm
rabbet	2430mm	2430±4mm	2440±4mm	-4mm	4mm
bottom	2448mm			-22mm	-13mm

3 FAILURE POINT IMPROVEMENT PLAN AND VERIFICATION

3.1 Failure Point 1 Improvement Results and Validation

Because the analysis of failure parts confirmed that there was a problem with their structure, the improvement result diagram of failure point 1 was designed, and then the overall structure optimization of the product was verified.

Respectively to draw the original car sunroof rail slider old machinery group structure diagram 1 and the improved new mechanical structure diagram 2, the new machinery group is in the entire history of the old mechanical group structure directly change the structure, pressure spring effect is to make the locking block into the locking hole, locking function limit block, a new structure to solve the motor sliding and locking groove sound problem.

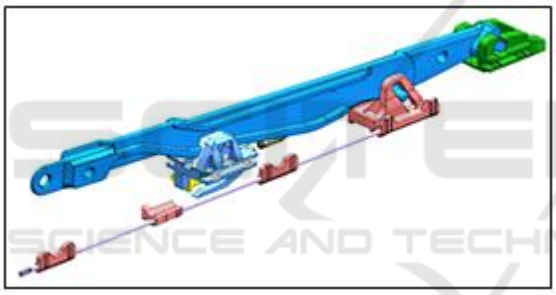

Figure 1. Old mechanical group structure diagram: guide block.

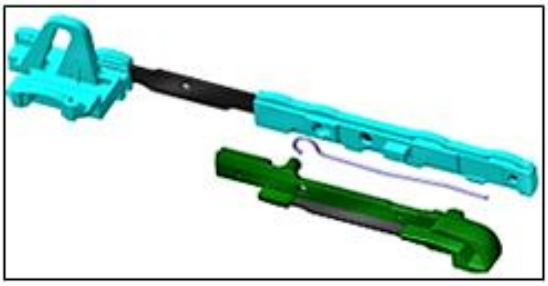

Figure 2. New mechanical structure diagram: guide block + lock block + compression spring assembly.

After asking the workers, most parts of the old mechanical group used no. 45 steel, so other parts of the new mechanical group still used no. 45 steel, because no. 45 steel after proper heat treatment, has high toughness, plasticity and wear resistance and other comprehensive mechanical properties, suitable for the mechanical group in a long time movement; The pressure spring of the new mechanical group, after searching for relevant information, can use the piano steel wire, the material itself has very high strength limit and elastic limit, can be widely used in small spring material, its quality and performance can meet the requirements.

Verification: before the durability test, the operation resistance of the old mechanical group in motion is tested and recorded. After a period of use, its movement resistance value is tested. After that, the movement resistance values generated during the operation before and after the endurance of the new mechanical group after the improvement were recorded, and the data before and after the endurance test of the mechanical group were compared and confirmed, as shown in the following table 7.

Conclusion: after testing, it is concluded that the trajectory of the new mechanical group is controllable and the motion resistance is small, so as to achieve a smoother movement and reduce the amount of deformation caused by the movement. No abnormal state (valid) was found in the mechanical group whose new result state was verified before and after the durability of its products.

3.2 Failure Point 2 Improvement Results and Verification

Because the experimental state of various pieces under various conditions was analyzed, the improvement result of failure point 2 was obtained, and then the condition change verification and sealing strip length management were further verified.

In the sealing strip processing, mold temperature control machine to change the mold temperature after curing. The main functions of changing mold temperature are: to improve the molding efficiency of products, reduce the production of defective products, improve the appearance of products, and restrain the defects of products; when the product is vulcanized, vulcanizing agent and accelerator are added. Under certain temperature and pressure conditions, the linear macromolecules in the rubber are transformed into three-dimensional mesh structure to realize the crosslinking vulcanization of the rubber. After vulcanization of the rubber, change the original strength of low, small elasticity, cold and hard heat viscosity, easy to age and other defects, improve wear resistance, resistance to swelling, heat resistance and other aspects, expanded its scope of application.

Table 7. Comparison of operating resistance.

experiment number	Old structures last	old structure durable	new structures last	new structure durable
1	108N	**163N**	69N	73N
2	94N	**173N**	68N	72N
3	103N	**176N**	79N	84N
4	92N	**165N**	61N	65N
5	88N	**181N**	66N	71N

The main factors affecting vulcanization degree and physical and mechanical properties of rubber are the amount of vulcanizing agent and accelerator, vulcanizing temperature and vulcanizing time, which have the following relationship:

(1) The larger the amount of vulcanizing agent and accelerator, the faster the vulcanization rate, the higher the degree of vulcanization can be achieved.

(2) If the curing temperature is increased by 10 ℃, the curing time will be reduced by nearly half.

(3) Curing time is an important part of curing process. If the time is too short, the degree of vulcanization is insufficient. Too long, vulcanization degree is too high.

They cannot reach the desired effect, only the appropriate curing time, can make the rubber reach a certain degree of vulcanization, to ensure the best Comprehensive performance.

Vulcanization time and tensile modulus has certain proportional relationship, in certain cases, curing agent, curing temperature within the scope of a particular seal of the longer the curing time, appropriate to reduce the mould temperature, the higher the tensile modulus, improve the sealing strip tension value contrast before and after the following table 8, high low temperature alternating test chamber to test sealing strip under the environment of high temperature contrast variation before and after sealing strip, such as table 9.

Validation: carry out the validation of condition change, strengthen the validation of seal strip length management, the value of condition change should meet the relevant standards of production process, and the tension value obtained before and after the test of seal strip length management verification should also meet the standard requirements of production process.

(1) After the mold temperature and curing time are changed, the tensile value of the seal strip is verified to confirm that the tensile value of the seal strip has an obvious effect.

Table 8. Improve the tension value of sealing strip before and after comparison.

differentiate	improve the former	After the improvement
Upper and lower mould temperature	Upper die: 245±10 ℃ Lower die: 270±10 ℃	Upper die: 230±10 ℃ Lower die: 260±10 ℃
Curing time	28s±2s	32s
Tension value	110N-118N	128N-133N

Table 9. Comparison of changes before and after sealing strip in high temperature environment.

differentiate	Before the high temperature	After the high temperature
improve the former	109N	102N
After the improvement	133N	126N

(2) After strengthening the management of the length of sealing strip, put the parts into high and low temperature boxes, and then compare the changes before and after, the improved sealing strip is more reasonable.

Conclusion: it can be concluded that the process improvement has significant effect (the scheme is effective) through the verification of the process improvement products.

After optimization and improvement of structure and process, the number of aftersales defects of car sunroof has been reduced a lot, and the expected target has been reached. And by analyzing the market expected, if after the improved structure and the optimization of process: improved after skylight according to logoff benchmark vehicle after-sale bad quantity have dropped significantly, the number of from dozens to several machines, reduce the failure rate of more than ninety percent, by this scheme to improve, each year can substantially reduce losses due to bad failure, decreased failure rate is reduced greatly.

4 SUMMARY

This chapter is mainly bad fault analysis, physical analysis of the soft shaft, motor, front beam and seal strip, etc., get the main reasons for the fault, and then according to its problems for research and improvement. Compared with the new and old mechanical group after the improvement of fault point 1, the structure is optimized to eliminate abnormal noise and unsynchronization. Failure point 2 is to strengthen the process, lower the upper and lower mold temperature and lengthen the curing time in the seal strip, so that the production of the seal strip in the strength and adapt to high and low temperature environment performance has been strengthened. Finally, after verification, the improvement scheme is reasonable and has certain reference significance in the optimization design of car sunroof, which has good practical engineering significance for improving design quality, reducing design cost and shortening development cycle.

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