Dynamic Response Analysis of Minicar Changan Star 6350

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ABSTRACT

Dynamic response analysis on the minicar Changan Star 6350 is finished by using MSC.Nastran. The simulation includes the modal analysis of the load-bearing frames of the minicar and the dynamic response considering the effect of the engine, car doors and wind shields under the real road loads. Reasonable results consistent with the experiments are obtained.

Introduction

Changan Automobile Group, which is located in the southwest of China, is one of the biggest minicar (including minivan) manufacture base in the country. In order to meet the competitive market, it requires to supply high quality and cheap vehicles in short development period. CAE tools, as the key means, are playing more and more important roles in the processes of the vehicle development.

The 'Changan Star' is a new type of high quality minicar developed by Changan Group this year. Its load-bearing structure is composed of chassis and body structure frame which are connected by welding. MSC.Patran and MSC.Nastran are used to simulate its static and dynamic characteristics. All the analysis results show good consistent with the experiments.

Finite Element Model

The 3D geometry of the Changan Star body-in-white is modeled by over 2 thousands of surfaces using SDRC/I-DEAS. Importing this geometry into MSC.Patran, we can build its finite element mesh with 32,685 nodes and 26,312 shell elements, see figure 1.

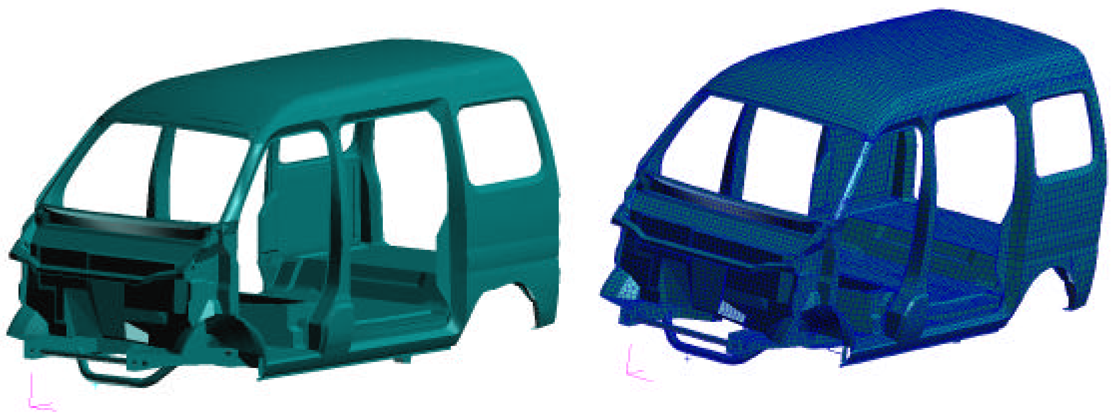

Figure 1 3D Geometry built in SDRC/I-DEAS and FE Mesh built in MSC.Patran

Free-Free Normal Modes

The excites acting on the vehicle usually can be divided into two parts, first is from the wheel unbalance, second is engine idle excite. The studying of the free-free normal modes can help us understand the basic and conceptual dynamic characteristics under these excites.

The first 100 normal modes were obtained using MSC.Nastran on IBM/RS6000. Its 1st torsion and 1st bending modes are shown in figure 2, in which,

1st torsion frequency = 29.9 Hz,

1st bending frequency = 54.9 Hz,

From table 1, we can find the good agreement between MSC.Nastran results and experiment datum.

Figure 2 MSC.Nastran Results: 1st Torsion and 1st Bending Normal Mode

Table 1 Natural Frequency between MSC.Nastran and Experiment Results

Normal Modes	**MSC.Nastran Results**	**Experiment datum**	**%**
1st Torsion Mode	29.9 Hz	28.4 Hz	5.28 %
1st Bending Mode	54.9 Hz	54.2 Hz	1.29 %

Another normal mode analysis model was built considering the wind shields structures and using RBE3 to include the influence of the engine mass and the car doors, see figure 3. The results shows that the new 1st torsion frequency now increase to 31.8 Hz, which is about 6.35% higher.

The comparison of the 1st torsion mode between the 2 models shows the obvious influence of the front windshield not only on the natural frequency value, but also on the mode shape, see figure 4.

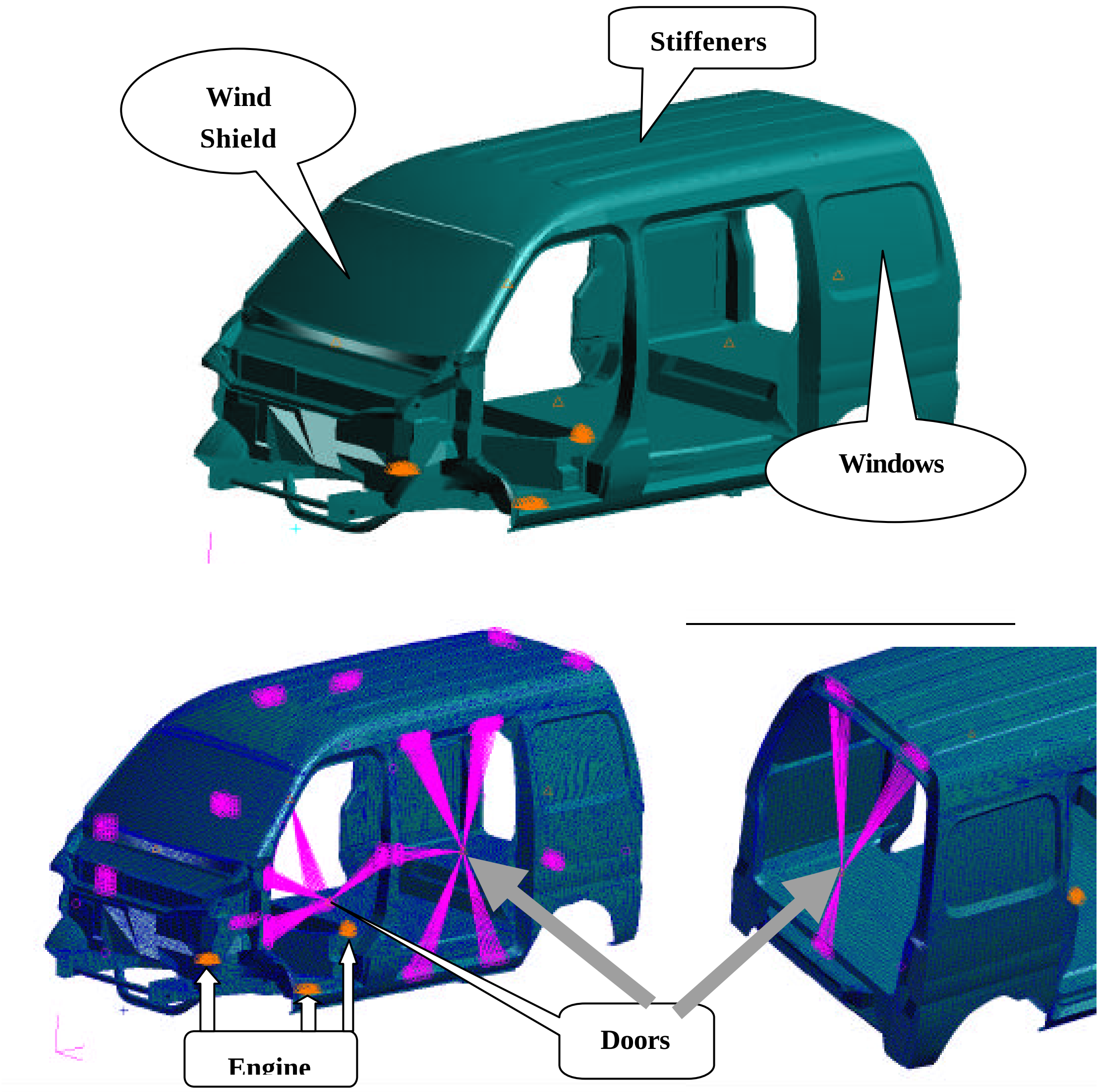

Figure 3 The modified FEM considering engine, wind shied and doors influence

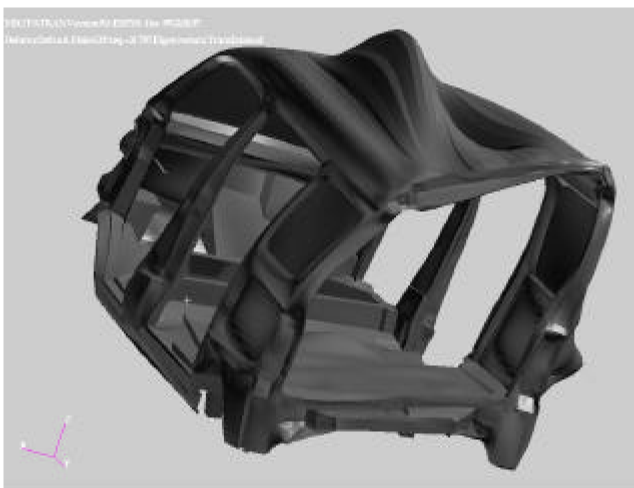

Figure 4 The 1st Torsion mode considering engine, wind shied and doors influence which gives its natural value,

F1 = 31.8 Hz

Transient Dynamic Response Under the Road Loads

There are totally 9 types of test road loads obtained from the experiments. All these loads are described as acceleration excitations on the wheels.

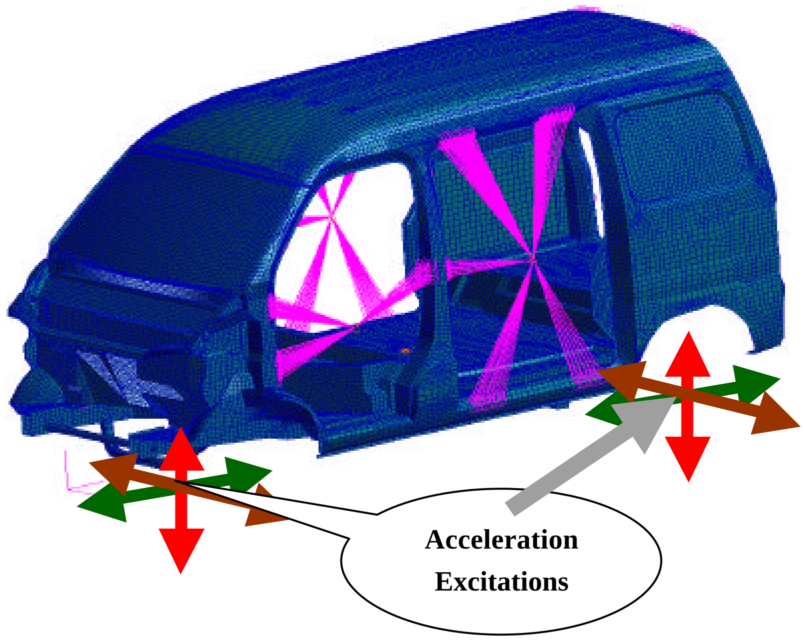

Figure 5 Base acceleration excitations acting on the vehicle

Using 'Large-Mass' dynamic method in MSC.Nastran, these base excitations can be easily applied on the vehicle structure, see figure 5. We choose the FEM which includes the wind shields structure and the influence of the engine and doors.

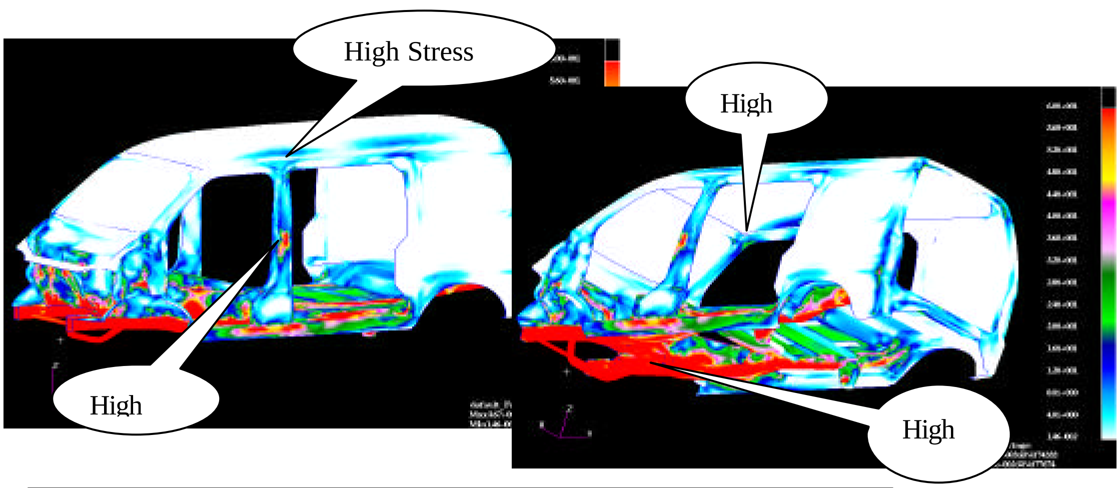

Figure 6 Typical high stress distributions

The results show the whole minicar's response. Figure 6 and 7 are the stress distributions at a certain time under a typical road load. It also shows the different behaviors between the chassis and the upper frame of car body, i.e., the high stress occur on the front part of the chassis and on the car body frame, the upper 2 corners of the front wind shield and the 3 doors connection parts are relatively dangerous regions which should be paid enough attention in the local structure design.

Conclusions

1. It's proven that the 'Changan Star Minicar' can meet the dynamic design requirements through simulation using MSC.Nastran and experiments. The MSC.Nastran results show good agreement with the test datum.

2. MSC.Nastran, as the main leader means of our CAE tools plays very important roles on the new vehicle development in Changan Automobile Group.

References

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3. MSC.Nastran Basic Dynamic Analysis User's Guide, MSC.Software Corp.

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