

Research on the strength feasibility of repairing collision-damaged Cab body

Hongming Pan^{1, a}, Huanyun Dai^{2, b}

¹ State Key Traction Power Laboratory, Southwest Jiaotong University, Chengdu 610031, China

² State Key Traction Power Laboratory, Southwest Jiaotong University, Chengdu 610031, China

^a*panhongmingswjt@163.com, ^bhuanyundai@163.com,

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Abstract. Nowadays, the high speed train develops very fast and it has irreplaceable traffic advantages. However, the collision damage of the high speed train body[1], which mainly includes the towing beam, boundary beam and sleeper beam, is a major obstacle to the development of the high speed train, so the research on the feasibility of repairing high speed train body is very imperative. This research adopts the method “replacement”, this method “replacement” is applied to repair the damaged car body. Finally, by the linear FEM and static load and fatigue load beach test, to assess whether the repaired car body can meet the requirements of design and operation after replacement. After the test and assessment, it proves that the replacement method can make sure the security and reliability of the damaged train body.

1. Introduction

Due to the continuous development of high speed train and its irreplaceable traffic advantages, high-speed train network will continue to expand, which is associated with the inevitable crash accident. However, the manufacturing cost is expensive, if we can repair the train just through replacing the structural elements, to reach and satisfy the operation strength indexes of the train, it will bring many benefits. On one hand, the resources can be used effectively, on the other hand, it can also save a lot of cost for the motor factory. Based on analysing the collision damaged cab body chassis, we can explore the feasibility of the replacement structure strength.



Fig.1 The structure diagram of the chassis

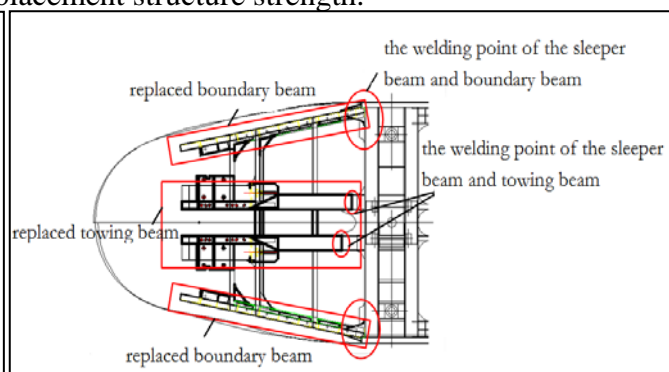


Fig.2 The structure diagram of the chassis

The object of the test is mainly composed of: sleeper beam and boundary beam, towing beam and floor. The purpose of the experiment is to verify the static strength and fatigue strength of the four welding point as show in Fig.2, and examine whether the maximum stress exceed the allowable stress.

2. Test program of the repair welding car body

Due to the test object is the partial body, however, test load and boundary conditions are given in the existing standards for normal vehicle; The test load and the boundary conditions cannot be directly used in this test, so it is necessary to equivalently treat the test load and the boundary conditions.

The main idea of the equivalent treatment is[2]: the distribution of test load and the boundary conditions distribution to the stiffness and stress is uniformity; Having analyzed the conditions influence of the deformation and stress distribution in the experiment and adjusted the experimental conditions, in this way, the trend of deformation and stress of the test object are same as the normal vehicle.

This test plan and evaluation criteria of static strength and fatigue strength condition are in accordance with JIS E 7106:2006 general requirements for design of railway locomotive vehicle passenger car body and EN 12663:2010 to the railway applications - railway vehicle body structure requirements.

Using the finite element simulation software ANSYS to calculate the strength of the chassis[3], and according to the results of the calculated stress to determine the paste location of strain gauges. The finite element model of the body chassis as shown in Fig.3 Fig.4.

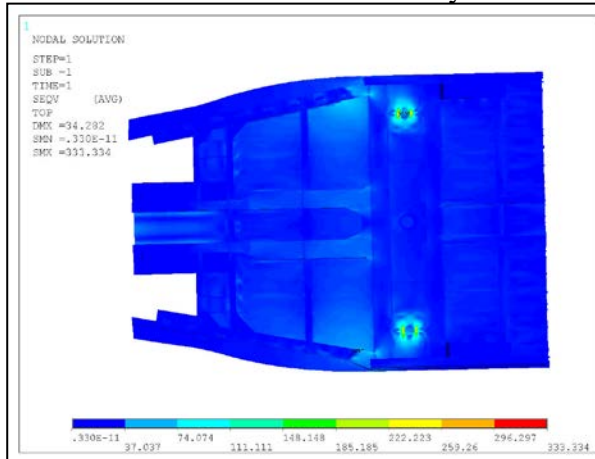


Fig.3 The finite element model of the chassis

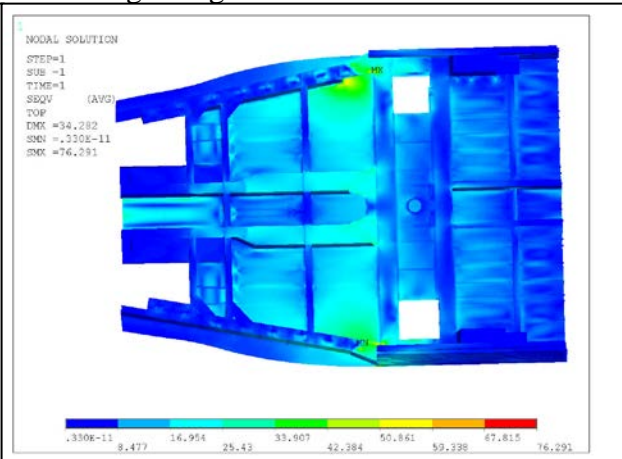


Fig.4 The finite element model of the chassis

3. Test carried out

3.1 Static strength test

According to the results of FEM stress, 164 measuring points had been arranged, among which, 118 was strain gauges, and the remaining 46 for the three-strain rosette. Test adopted MTS hydraulic servo system, DH3821 data acquisition equipment and 256 data acquisition channels. Strain gauges were arranged symmetrically, so that we can contrast the results.

MTS hydraulic system static load test had been carried out on the chassis, and the maximum strain of each strain gauge had been selected to make the chart, as shown in Fig.5-Fig.10.

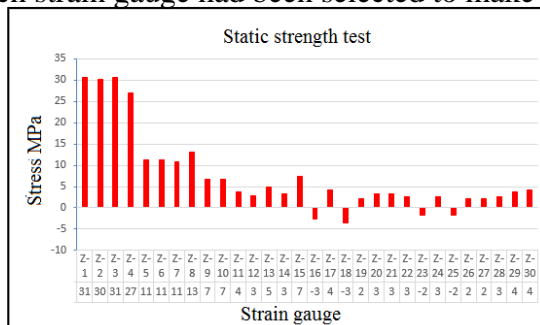


Fig.5 Stress of the strain gauges

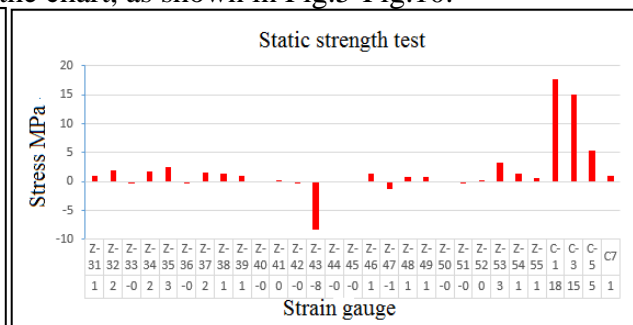


Fig.6 Stress of the strain gauges

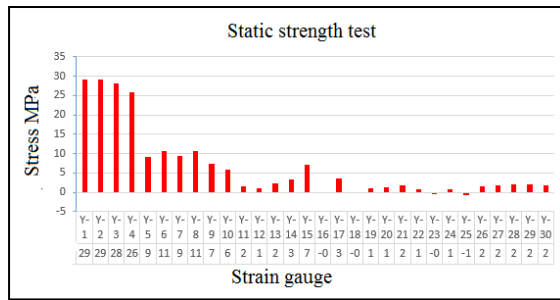


Fig.7 Stress of the strain gauges

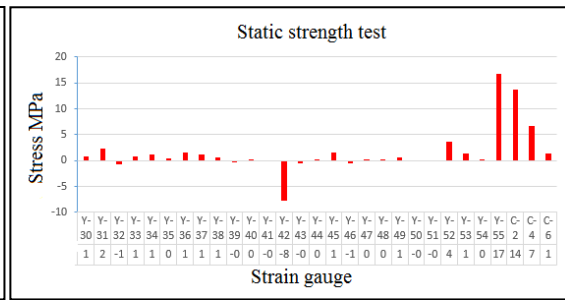


Fig.8 Stress of the strain gauges

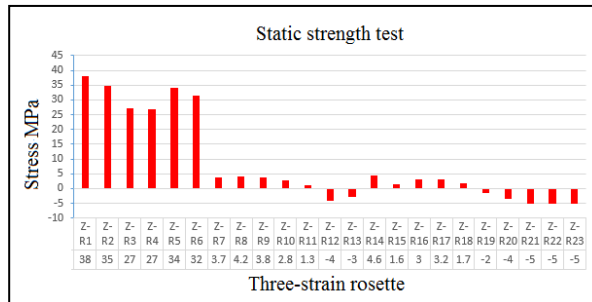


Fig.9 Stress of the strain gauges

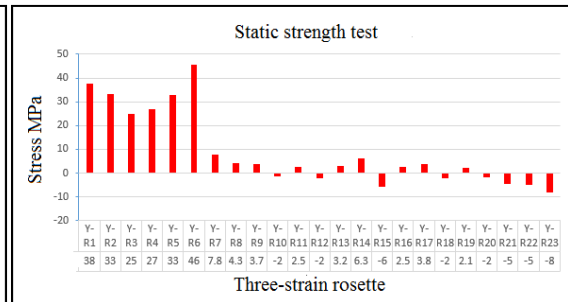


Fig.10 Stress of the strain gauges

3.2 Fatigue strength test

Chassis fatigue test had been divided into three stages, a total of 10 million times load cycles. The first stage, contains 6 million normal load cycles, which was treated as a basic verification. No cracks were found after using magnetic powder inspection; Then the second stage, which contains 2 million load cycles. The dynamic load size was based on the first stage, load increases 0.2 times than the first stage. No cracks were found after using magnetic powder inspection; The third stage contains 2 million load cycles. On the basis of the first stage, the dynamic load size increased 0.4 times, no cracks were found after using magnetic powder inspection.

Having selected the maximum strain of each strain gauge to make the chart, as shown in Fig.11-Fig.16.

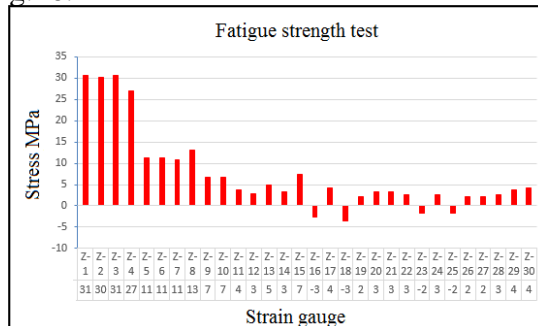


Fig.11 Stress of the strain gauges

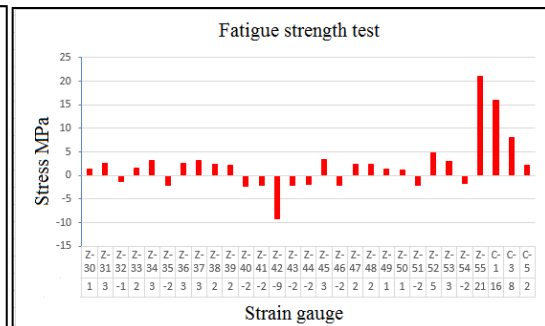


Fig.12 Stress of the strain gauges

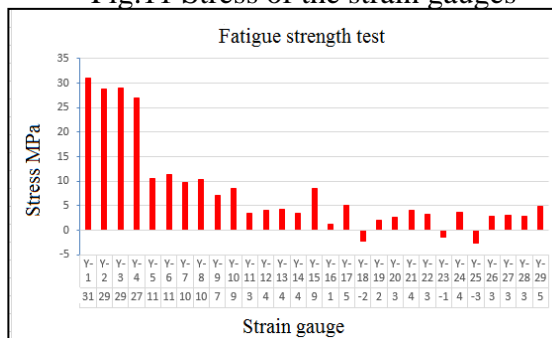


Fig.13 Stress of the strain gauges

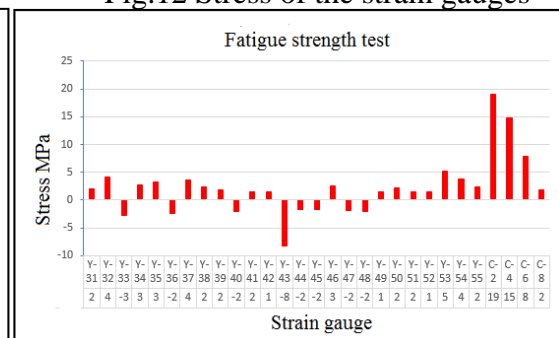


Fig.14 Stress of the strain gauges

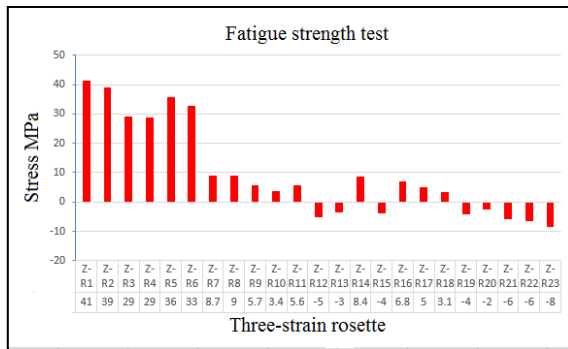


Fig.15 Stress of the strain gauges

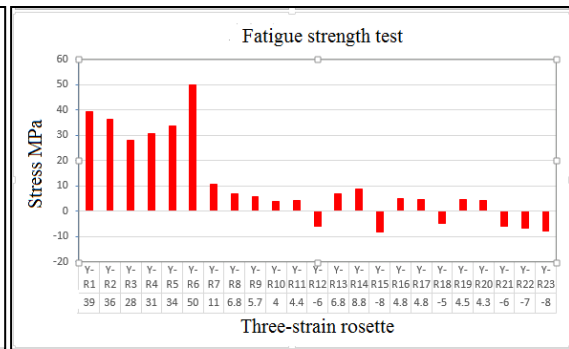


Fig.16 Stress of the strain gauges

4. Test results and analysis

The static strength test and fatigue strength test results are as follows:

In the static strength test, the maximum stress occurs at the Z-R1 strain gauge, the value is 38 MPa, tensile stress. Maximum stress does not exceed the allowable stress, chassis does not produce residual and permanent deformation.

In the fatigue strength test, the maximum stress occurs at the third stage of the fatigue strength test at the Y-R6 strain gauge, the value is 56 MPa, tensile stress. Maximum stress does not exceed the allowable stress, so the chassis does not produce residual and permanent deformation. No cracks were found after using magnetic powder inspection using magnetic powder inspection.

5. Summary

Through the static strength test and the fatigue strength test of the chassis, the following conclusions can be obtained:

- (1) ANSYS calculation and the strength test proved that the strength of the collision damaged body chassis meet the requirements of design and operation.
- (2) The results of the ANSYS calculation were same as the actual bench test, which proves that the equivalent treatment is reasonable.
- (3) The maximum fatigue stress of the chassis occurs at the welding position of the boundry beam and sleeper beam. The weld seam quality impacts the fatigue strength greatly. So when repairing the car body by welding, we must pay attention to the welding seam quality.

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