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2100 HP DIESEL ELECTRICAL LOCOMOTIVE RUNNING TEST

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ABSTRACT: The diesel – electrical locomotives are used from Romanian freight operators to run trains where electrical locomotives can't run. At Romanian Railways, one of diesel locomotives is 2100 HP Sulzer diesel – electrical locomotives.
KEYWORDS: strain gauge, experimental stress analysis, Hottinger

❖ INTRODUCTION

The early diesel - electrical locomotives manufactured in Romania under Sulzer license had leaf type springs at secondary suspension. During time, the operators wasn't satisfied about leaf type springs so it was necessary a replacement with other types of spring. One of the solutions was using of rubber springs. Because the dimensions of the rubber springs are others than leaf springs the frame of the bogie was modified so it was necessary to perform an experimental stress analysis with strain gages. According to the Railway standards, the tests can performed on bench test or with locomotive in circulation with a method accepted at Romanian Railways. Because in Romania are only wagon/passenger cars bench test, it was necessary to develop the test method necessary for testing the locomotive's bogie. This paper presents the method which was use for testing.

Figure 1 and figure 2 illustrate the two types of secondary suspension (leaf springs and rubber springs).

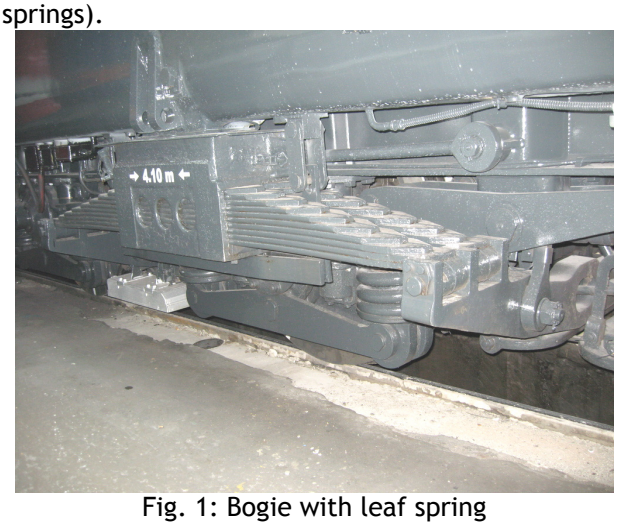

Fig. 1: Bogie with leaf spring

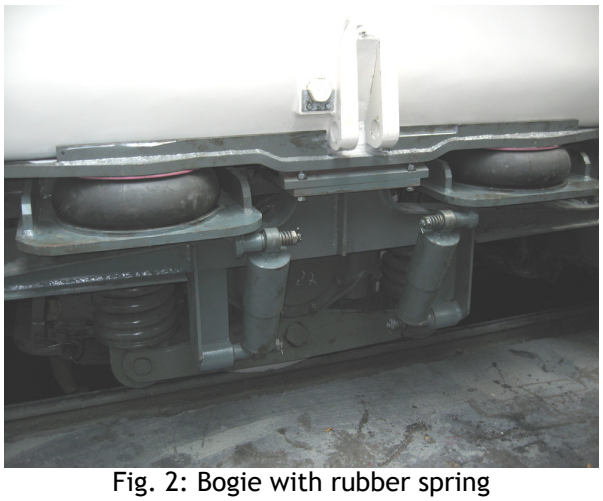
Fig. 2: Bogie with rubber spring

❖ TESTS

The tests were performed in two steps:

- static tests,
- dynamic tests.

During the static test, were recorded the static stress σ_{st} due the locomotive's body action on the bogies.

Recording of the stress variation (dynamic components of the stress) $\Delta\sigma_+$ and $\Delta\sigma_-$ were made during locomotive's circulation on 100 km/h speed. Based on values of $\Delta\sigma_+$ and $\Delta\sigma_-$ were calculated outmost values of the stress with the equations:

$$\sigma_{\max} = \sigma_{st} + \Delta\sigma_+ \quad (1)$$

$$\sigma_{\min} = \sigma_{st} + \Delta\sigma_- \quad (2)$$

The medium value of the stress results from the equation:

$$\sigma_m = \frac{\sigma_{\max} + \sigma_{\min}}{2} \quad (3)$$

The amplitude of the stress results from the equation:

$$\sigma_v = \frac{\sigma_{\max} - \sigma_{\min}}{2} \quad (4)$$

The σ_v values were comparative with the values from Goodman – Smith diagrams presented in annex F.3 of the report ERRI B12/RP17. The allowable condition is:

$$\sigma_v \le \sigma_{vadm} \quad (5)$$

In the figure 3 is presented graphically how the tests were done.

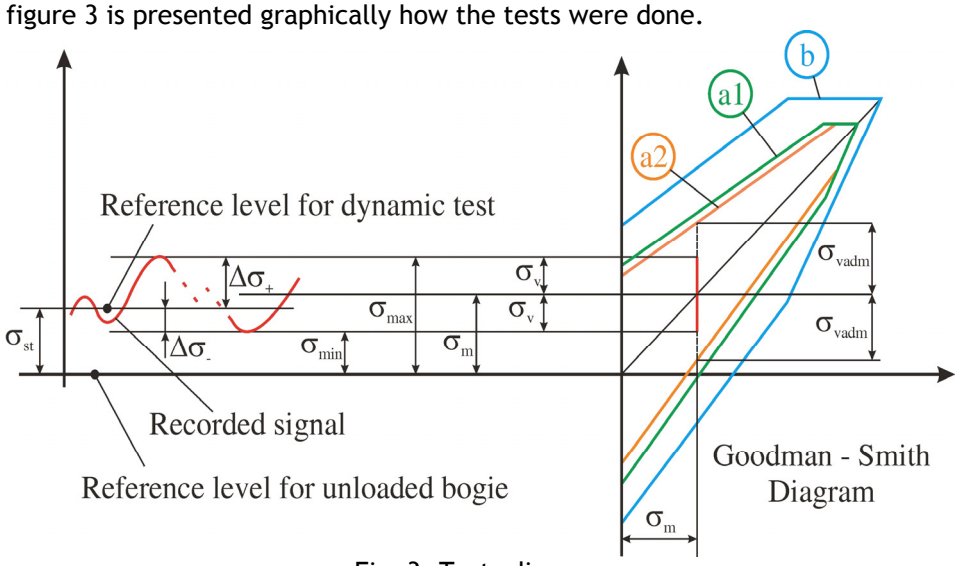

Fig. 3. Tests diagram

The measurement points were located in the relevant areas of the modified bogie's frame.

The measurements were performed in 10 points. Hottinger LY11-10/120 strain gages were glued on the elements of the bogie with Hottinger Z70 adhesive. The strain gages were connected at measuring devices with cables.

The measurements were performed with Hottinger Centipede 100 Multipoint Measuring Unit (for the static tests) and Hottinger MGCplus (for the dynamic tests). The measuring devices Centipede 100 and MGCplus were connected to a laptop computer. The acquisition software used was Catman 4.5 (an Hottinger product).

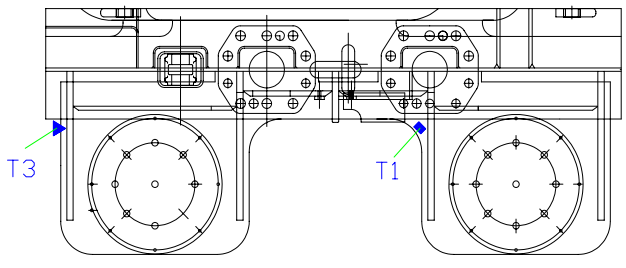

Fig. 4. Strain gauges T1 and T3

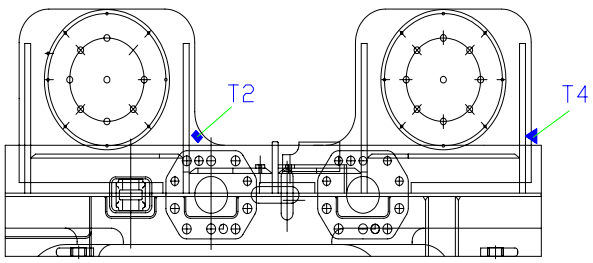

Fig. 5. Strain gauges T2 and T4

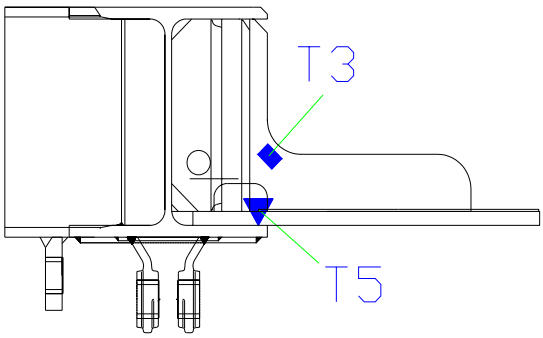

Fig. 6. Strain gauges T3 and T5

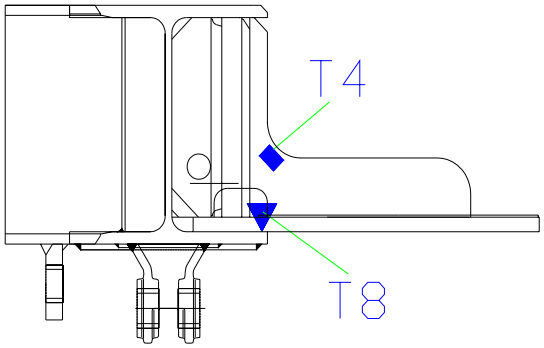

Fig. 7. Strain gauges T4 and T8

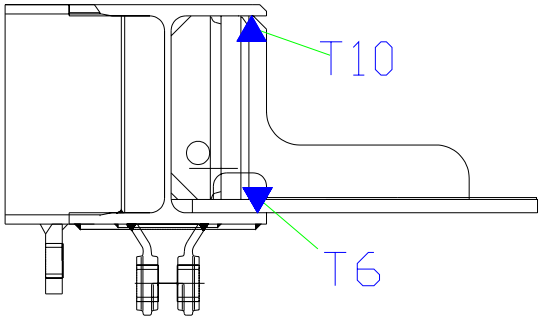

Fig. 8. Strain gauges T6 and T10

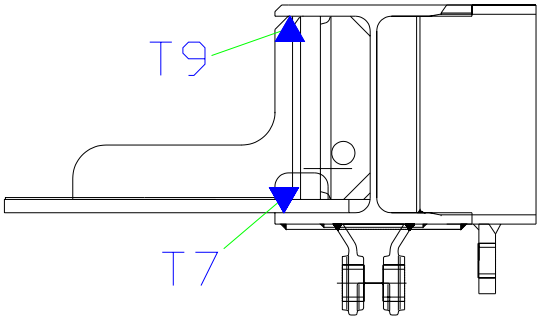

Fig. 9. Strain gauges T7 and T9

❖ RESULTS

The dynamic diagrams of the measurement points are shown in figures 9÷14 (there are presented only the diagrams for the most stressed points static and dynamic).

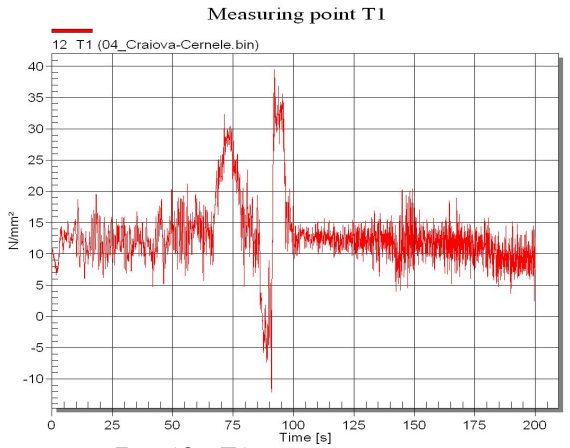

Fig. 10. T1 strain gauge stress

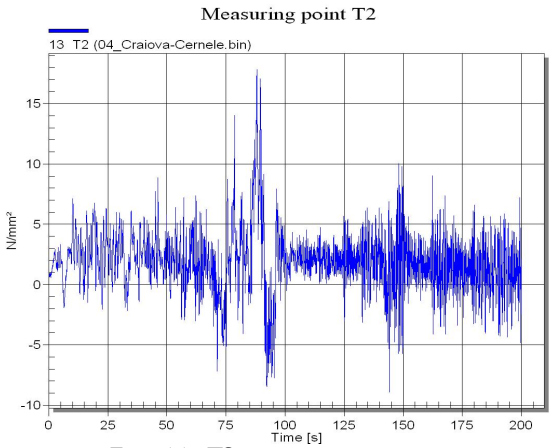

Fig. 11. T2 strain gauge stress

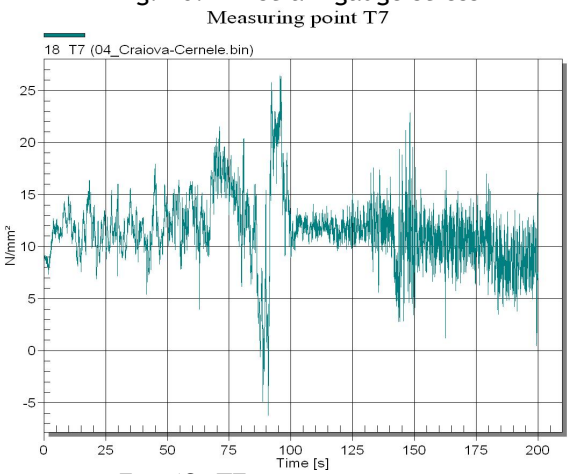

Fig. 12. T7 strain gauge stress

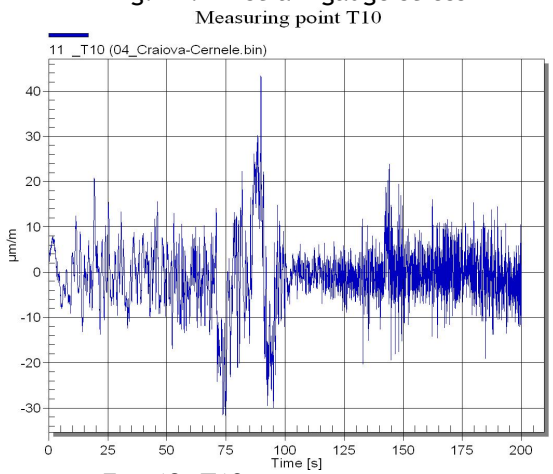

Fig. 13. T10 strain gauge stress

During the tests, the measuring tests were on curve "a2" and "a1" (from the Goodman – Smith diagram) – table 1.

Table 1: Position of the measuring points on Goodman - Smith diagram

SG	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Curve	a2	a2	a2	a1	a2	a2	a2	a2	a2	a2

❖ CONCLUSION

The results, was smaller than permissible stress, so we can concluded that the design solution used by manufacturer was good.

Based on test results, the designer can improve his design to increase the quality of the final product.

After the tests the new certification from the Railway Commission was obtain.

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