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Progressive damage assessment of cyclic stresses on the mechanism of rail steels on curved line railway

S. Belghit[1] and O. Allaoui[1]

[1] Department of Mechanical Engineering, Faculty of Technology

Amar teldji university Laghouat, Algeria

Abstract

This Today it is generally electrically powered. The commercial speed of the tramway is higher than that of the bus, the car its platform is essentially on its own lane (that is to say excluding other modes of traffic) and it has priority over other vehicles at crossroads. This speed makes it attractive and makes it possible to envisage a new organization of travel in urban areas. Maintaining this gain is a priority and this by following a preventive maintenance program.
The planning of a preventive maintenance work requires a good fault diagnosis
Our study consists of modeling the fatigue effect on a simultaneous, left and right tram rail section using the finite element method using solidworks software
According to our analysis results, the traces of fatigue appearing on the left rail are less significant compared to the right rail.
An accurate prediction of the profile fatigue evolution of the rail to improve safety and reduce costs preventive.

Keywords: tramway, rail, fatigue, solidworks.

1 Introduction

Transport by tramway is an effective achievement in the cities of Ouargla, in southern Algeria, as it contributed to solving the transport problem. It also contributed to reducing gas emissions from fossil fuel combustion.

Maintaining this gain is a priority, and this is by following a preventive maintenance program, in this study the use of the solidworks software it shows us the areas of high stress concentration in left and right curved rail.

Failures caused by rail wheel contact fatigue are unavoidable operational problems on the tracks due to the high stresses developed from the contact of these two elements and Progressive damage assessment of cyclic stresses on the mechanism of rail steels on curved line railway [1].

Rails are of great importance in ensuring the safety and reliability of rail transport.

This study consists in modelling the fatigue effect on a section of tram rail, simultaneous, left and right by the finite element method using the software solidworks [2] [3].

The stresses generated by the passage of the wheel on the rail are obtained by applying a static load to the contact zone (wheel, rail) existing in the middle of two fixing points [4] [5] [6].

The loads considered in our study are respectively:

- Vertical force equal to the weight of the tram and the passengers

- Horizontal friction force with a direction opposite to the movement of the tramway

- Centrifugal force relative to the speed of the tram and the radius of the rail.

2 Methods

Our study consists of modelling the fatigue effect on a simultaneous, left and right tram rail section using the finite element method using solid works software.

The stresses caused by the wheel arch on the rail are obtained by applying a static load to the contact area (wheel, rail) existing in the middle of two attachment points. The charges considered in our study are respectively: Vertical force, Horizontal friction force and Centrifugal force, the two rails of a section of tram Figure N°1.

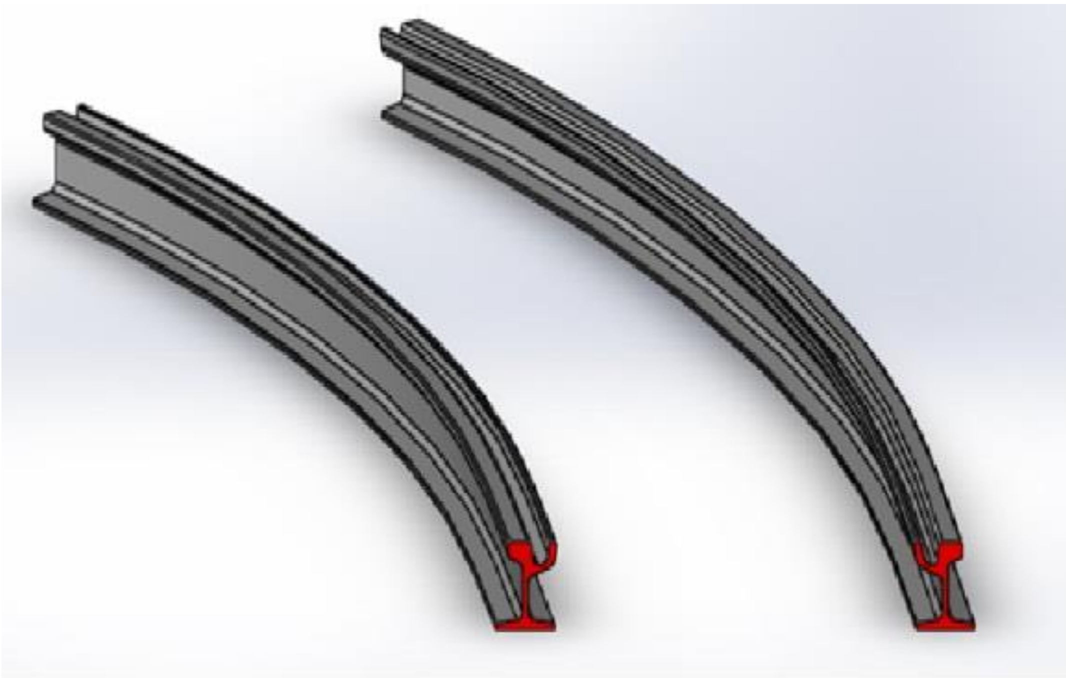

Figure 1: Rail curved

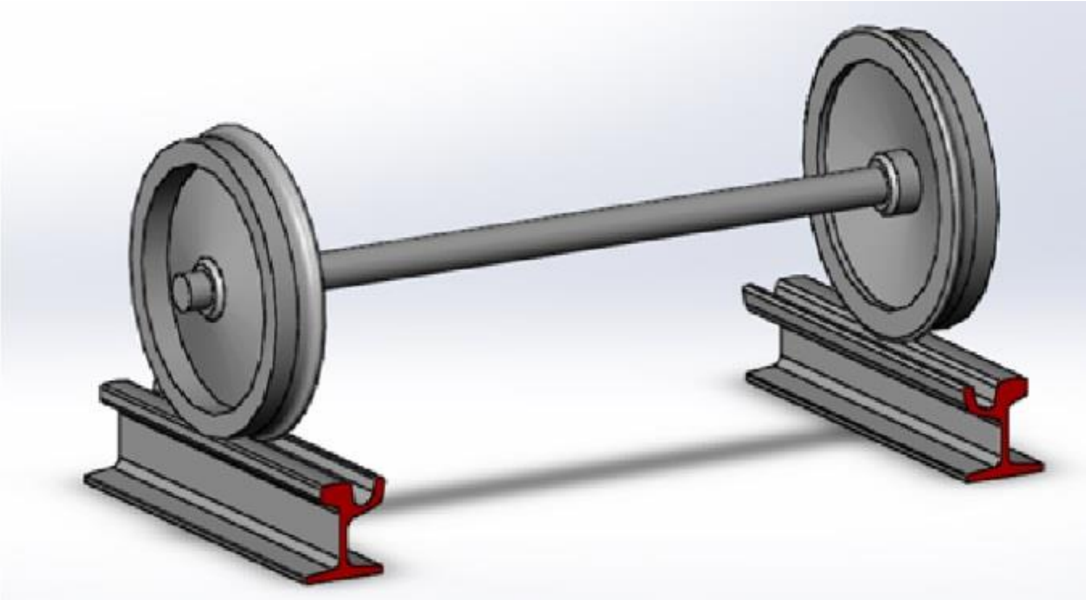

Figure N°2. 3D model of wheel/rail.

Main technical parameter
The loading weight tram and 6 passengers /m2 : 80 Tons
The length of the right and left rail section is 700 mm
Tram speed in curves is 10 km/h
The radius of curvature of the rail is 25 m
The right profile of the rail is shown in figure N°03

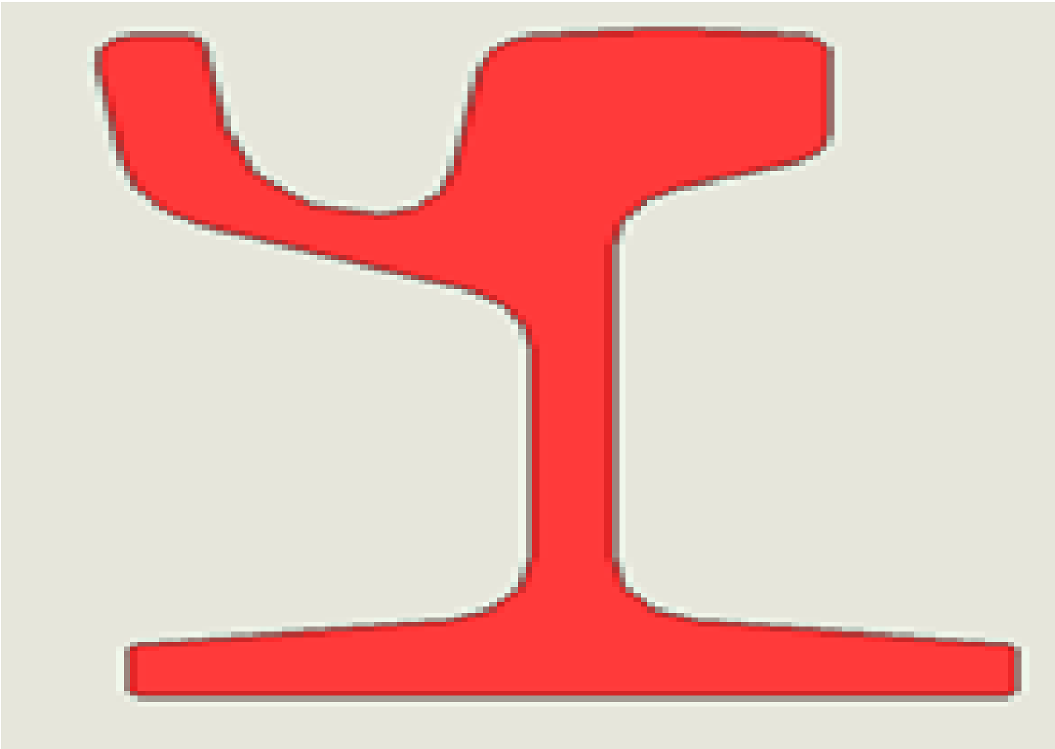

Figure N°3. The profile of the rail

Establishment of the calculation model:

The hypothesis considered in our study consists in blocking a section of right and left rail by its lower part with a recessed frame that prevents movement dx=dy=dz=0 and rotation redx=redy=redz=0 for points A and B shown in Figure 4.
That case her self-Translated in reality by the presence of bolts with platinum on two sides rail. The distance between the two points of fixation is of L = 700 mm.

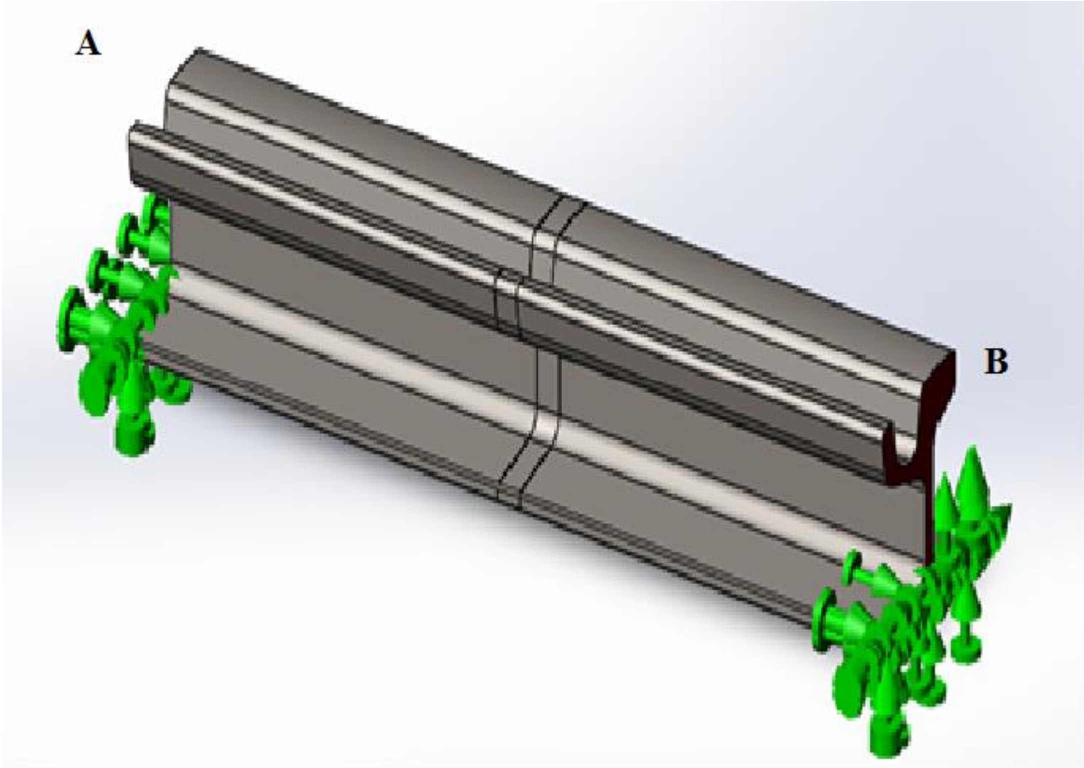

Figure 4 : Points of fixation

The maximum weight of the tram is distributed distinctly on the rails right is left in two ways in the middle of the section on an area that does not access 10 mm wide. It represents the point of contact of the wheel with the rail. This maximum weight is schematized by a vertical vector equal to the sum of the weight of the empty tram plus the weight of the passengers that currency on 16 (16 represents the number of wheels of the tram). Figure 5

Fv = 80 Tone / 16 = 5 Tone = 50000 N.

Ff = μ x M xacc = 0.1 x5000 x 1.2 =600 N with:

The coefficient of friction with lubrication between steel and steel is $\mu = 0.1$

The acceleration in the curved area is 1.2 m/s^2

The centrifugal force Figure 5.

$$F_C = \frac{M.V^2}{R_{min}} = \frac{5000x\left(\frac{10000}{3600}\right)^2}{25} = 1534 \text{ N}$$

The max weight is M= 5000 kg.

The speed in the curved area is V= 10 Km/h = $\frac{10000}{3600} = 2.77$ m/s.

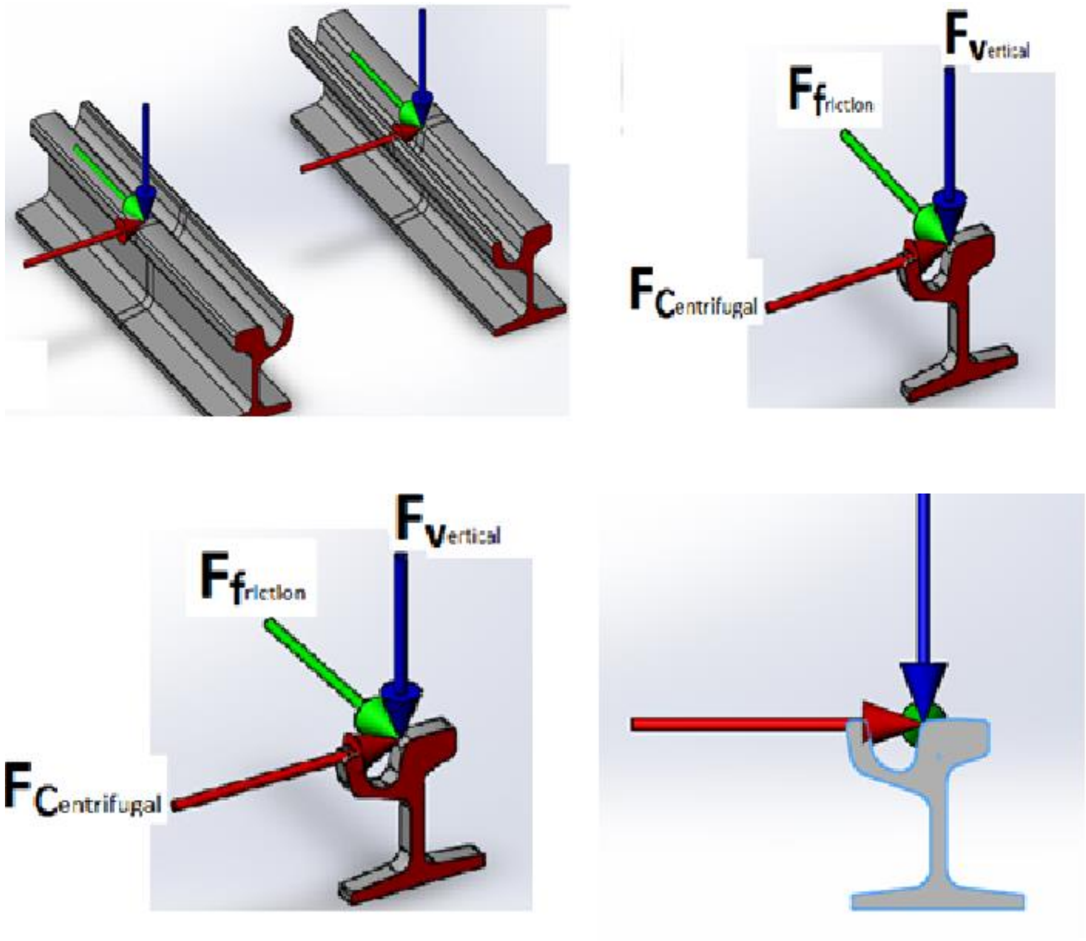

Figure 5: The distribution of forces acting tow rails

3 Results

The numerical fatigue analysis requires a static study of the forces applied to the right and left rail section. The cyclical loading of this event results in areas of fatigue appearing in the middle and lower parts of the rails.
The static numerical analysis of the 3D model under solidworks, allows us to obtain the distribution of the equivalent von Mises stresses, deformation and shear along the left and right rail.

Right Rail: In this case, static analysis was performed to determine the distribution of equivalent Von Mises, bending and shear stresses along the right rail. Figures 6, 7, 8, 9, 10 and 11 show the result of these constraints in the form of a gradient color diagram from blue to red. Blue represents the least infected areas and red represents areas of high stress concentration.

The maximum Von Mises stress is 251 MPa, the maximum displacement is 0.287 mm and the minimum safety coefficient is 710/251 = 2.82.
The maximum number of cycles for fatigue zone appearances is 1.4 x 108.

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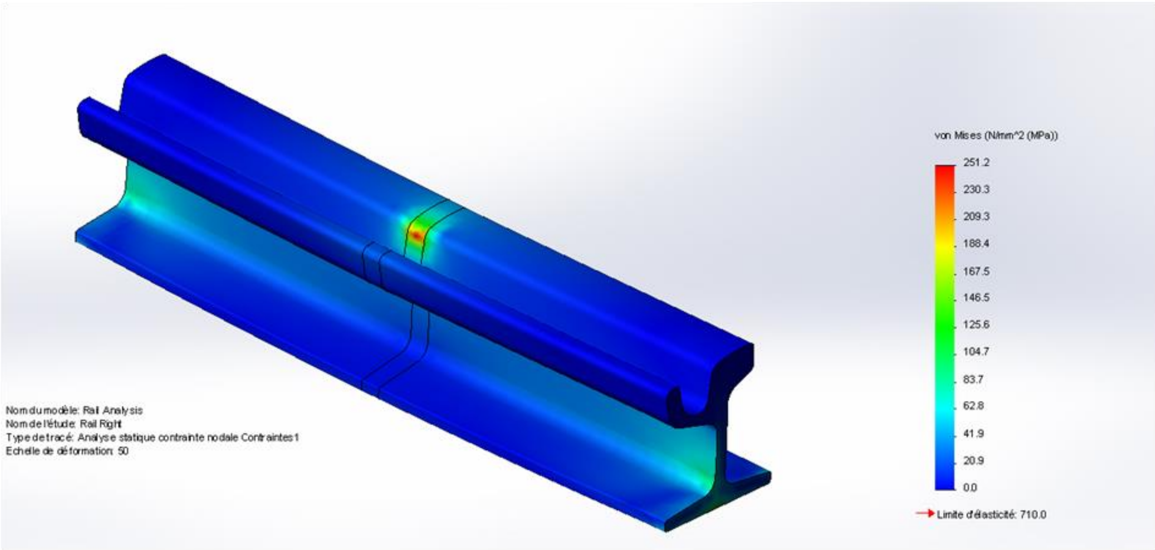

Figure 6 : Equivalent Von Mises contraint

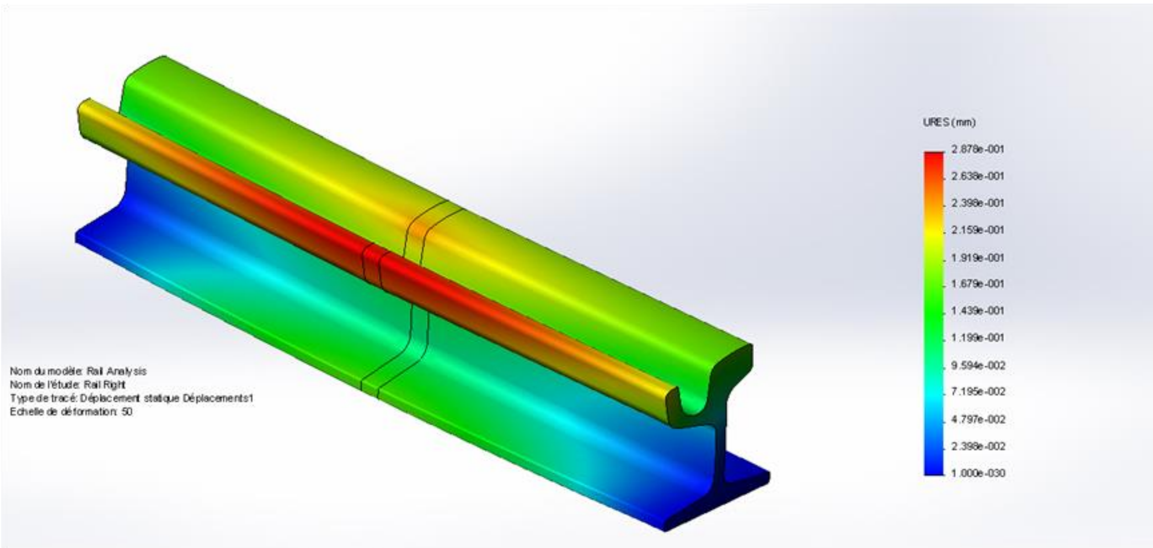

Figure 7 : Displacement Contraint

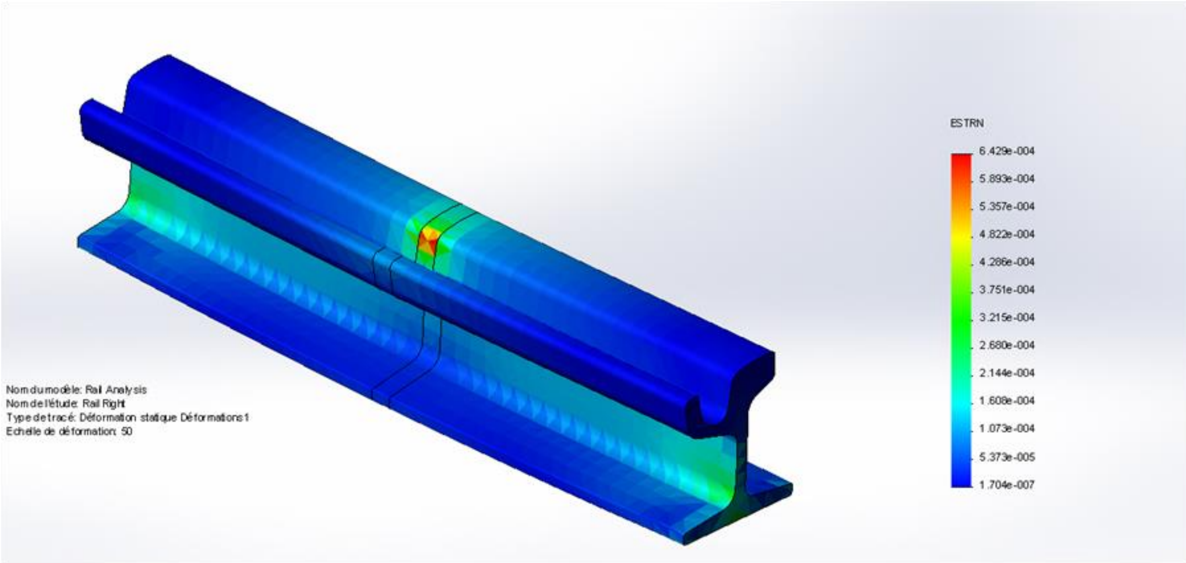

Figure N°8 : Strain stress

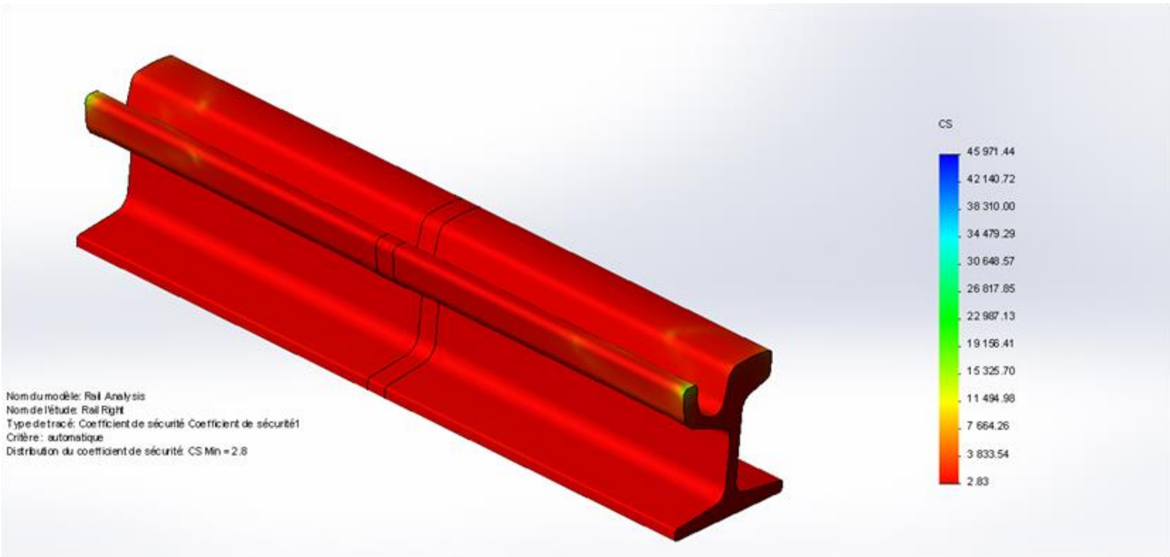

Figure N°9: Distribution of the safety coefficient

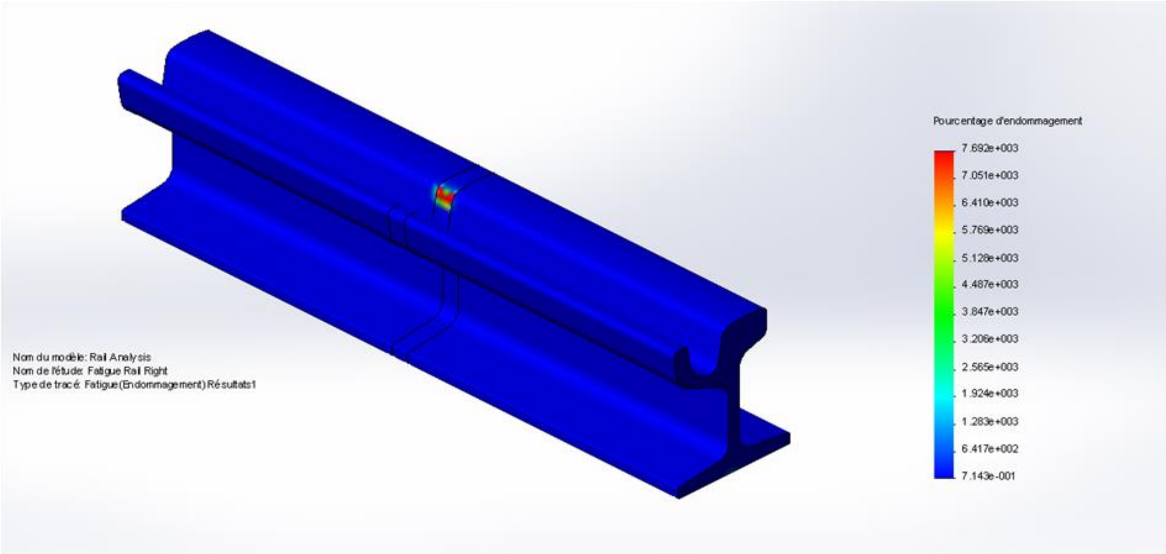

Figure 10: Percentage of damage (fatigue)

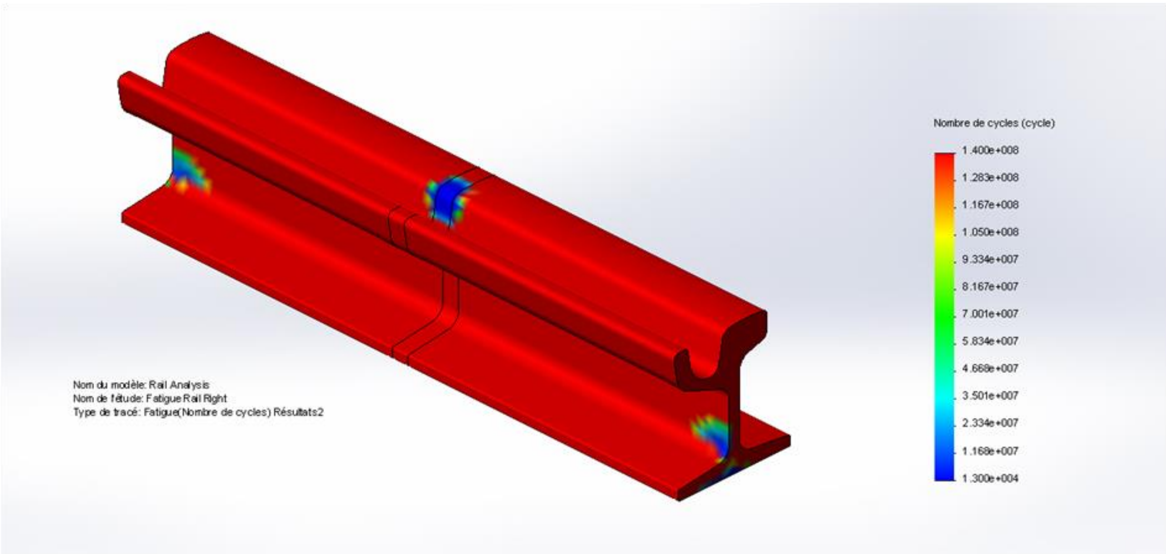

Figure 11: Number of cycles.

Rail Left: In this case, static analysis was performed to determine the distribution of equivalent Von Mises, bending and shear stresses along straight rail. Figures 12, 13, 14, 15, 16 and 17 show the result of these constraints in the form of a gradient color diagram from blue to red. Blue represents the least infected areas and red represents areas of high stress concentration.

The maximum Von Mises stress is 153 MPa, the maximum displacement is 0.326 mm and the minimum safety coefficient is 710/153 =4.64.

The maximum number of cycles for fatigue zone appearances is 1.4 x 108.

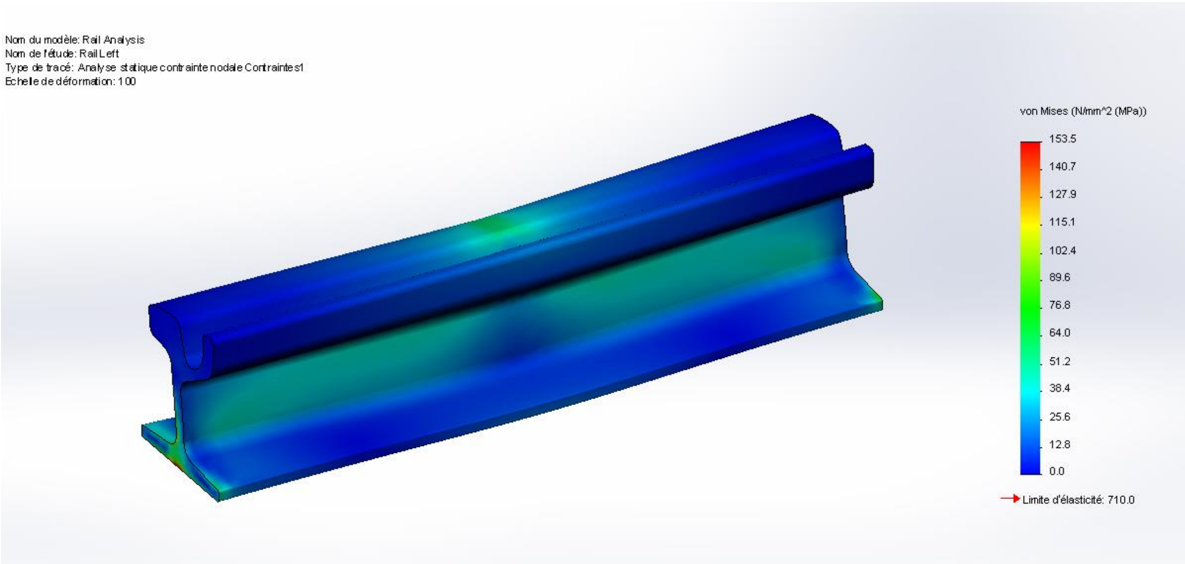

Figure 12 : Equivalent Von Mises contraint

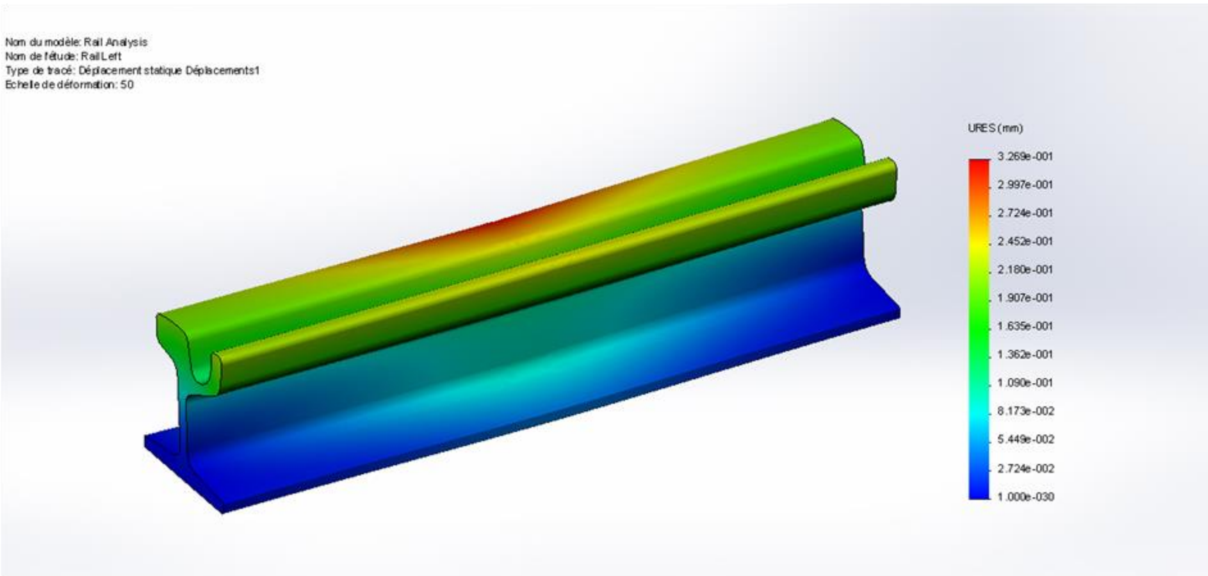

Figure 13 : Displacement Contraint

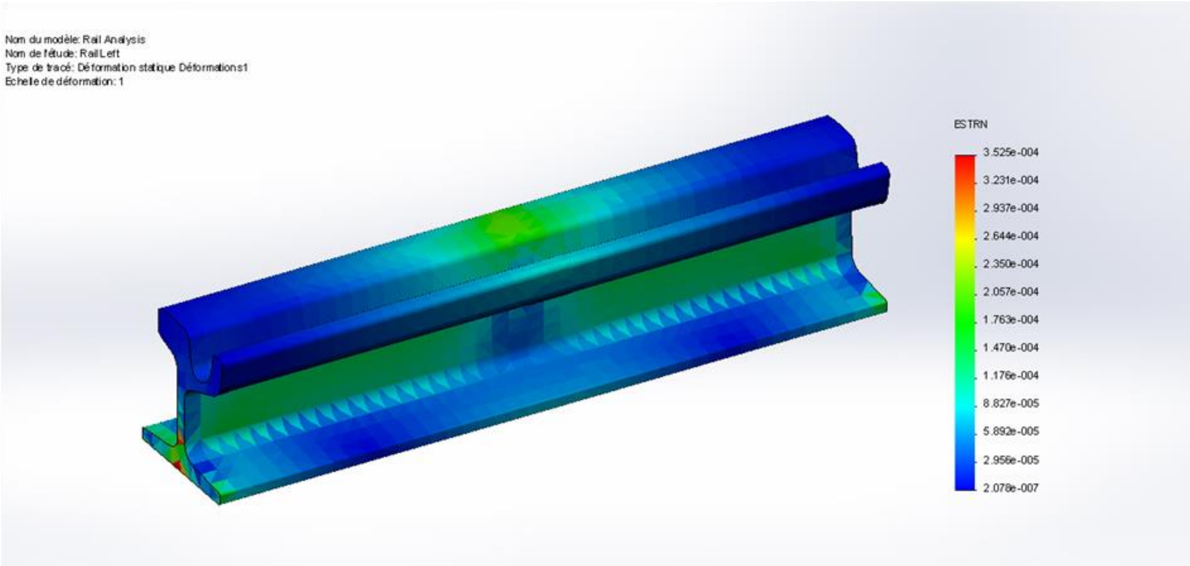

Figure N°14: Strain stress

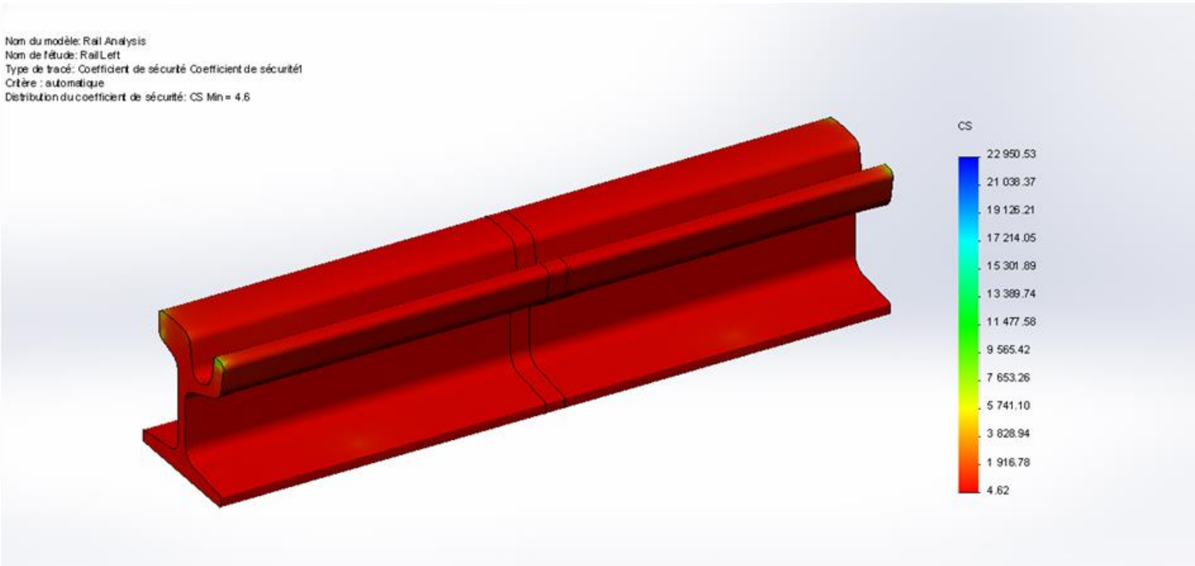

Figure N°15: distribution of the safety coefficient

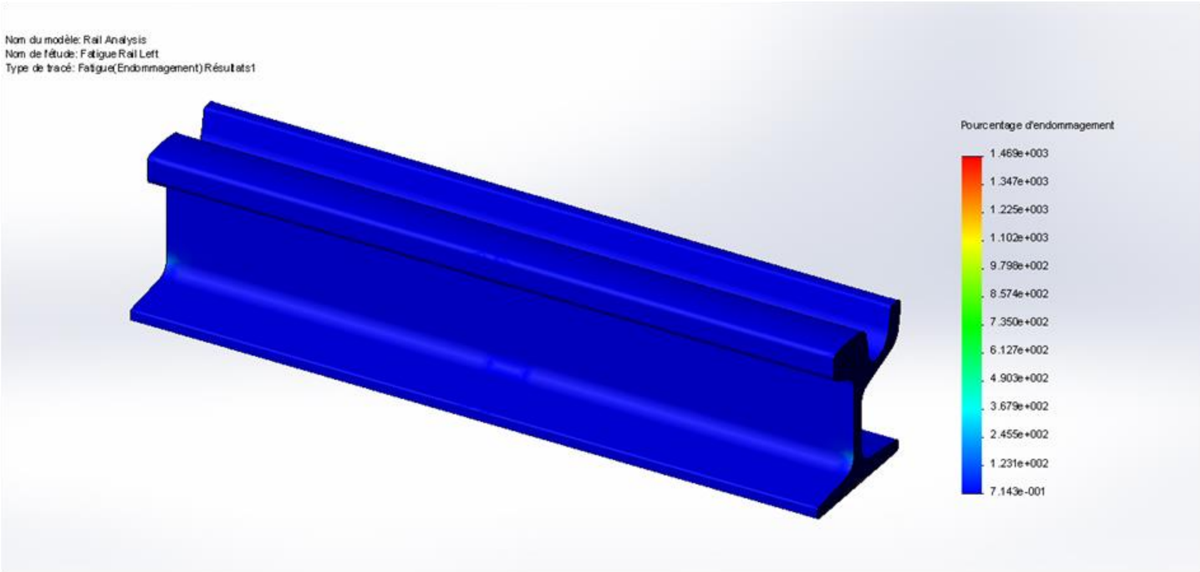

Figure 16: Percentage of damage (fatigue)

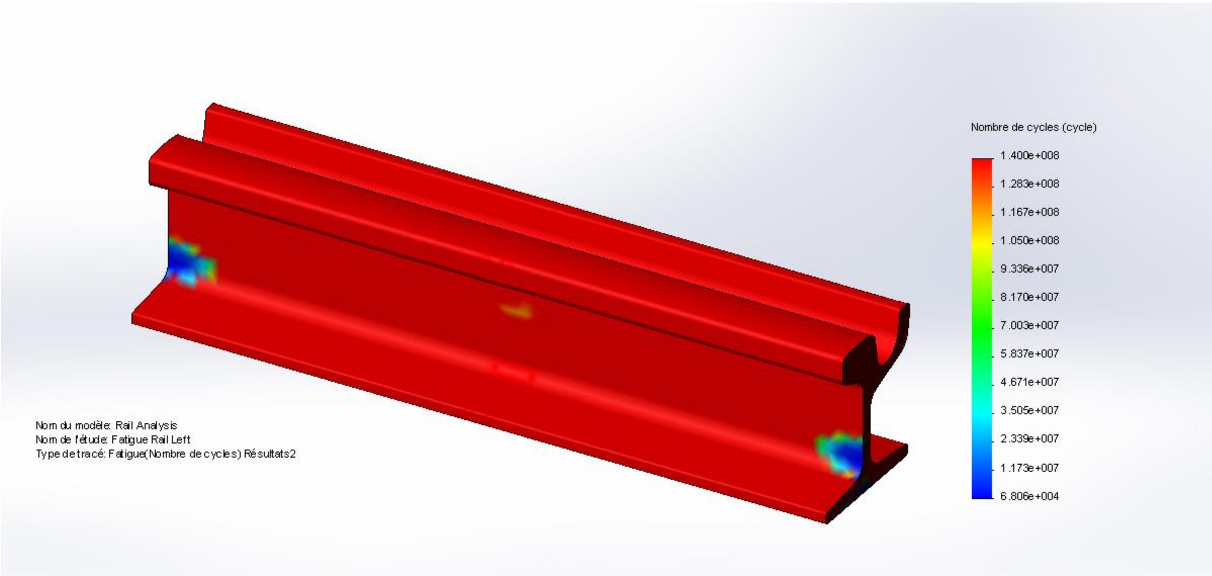

Figure 17: Number of cycles.

4 Conclusions and Contributions

The numerical analysis of a 3D rail under applied static load for the positions of a curved rail has been investigated in this paper. The result was obtained using solidworks. Compressions of the rail between two sleeper attachment points.

According to our analysis results, the traces of fatigue appearing on the left rail are less significant compared to the right rail.

Good planning of non-destructive testing in the stress concentration zone will allow us to know the state of fatigue of the rail and perhaps the appearance of cracks for the treatment or to proceed with the change of rail in the curved area, to avoid failure.

An accurate prediction of the profile fatigue evolution of the rail to improve safety and reduce costs Preventive, it also contributes to the precaution against the sudden stop of the tram, which will affect the circulation of transport.

References

[1] T .Jendel,. Prediction of wheel profile wear - comparisons with field measurements. In Proceedings of the Inter Conference on Contact Mechanics and Wear of Rail/Wheel Systems, Tokyo, Japan, 25–28 July 2000.

[2] E. Gardiea, Numerical analysis of rail joint in a vertical applied load and determining the possible location of joints 2022.

[3] S. Guta,Stress Analysis of Rail Joint under Wheel Load June 2016.

[4] T. M. Beagley, Severe wear of rolling/sliding contacts. Wear, 1976

[5] P. J. Bolton, , Clayton, P. Rolling-sliding wear damage in rail and tyre steels. Wear, 1984

[6] S. yueZhang ,Study on wear and rolling contact fatigue behaviors of defective rail under different slip ratio and contact stress conditions