International Journal of Mechanical Engineering (IJME)
ISSN(P): 2319-2240; ISSN(E): 2319-2259
Vol. 3, Issue 4, July 2014, 29-34

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

PREVENTIVE MAINTENANCE OF RAIL VEHICLE CHASSIS BY OPTIMIZATION OF DIMENSIONING PARAMETERS

ZEMOURI ZAHIA[1], HAMADACHE HAMID[2], TOUATI RAMDANE[3] & BOUTI AMINA[4]

[1,4]Department of Mechanical Engineering, University Badji Mokhtar Annaba, Research Laboratory in Mechanics Materials and Industrial Maintenance, Anaba, Algeria

[2,3]Department of Mechanical Engineering, University Badji Mokhtar Annaba, Research Laboratory of Advanced Technologies in Mechanical Production, Annaba, Algeria

ABSTRACT

Among the complex metal structures, we find the chassis locomotive frame receiving various static and dynamic actions are often the seat of constraints that may cause local ruptures in the elements of the frame The detection of the much requested zones of the frame is an important operation which makes it possible to envisage the possible reinforcements necessary for the consolidation of the frame. Also, the determination of the exact position of the reinforcing cross requires a judicious calculation. Often ruggedness tests are performed on the chassis prototypes at specialized testing centers to certify compliance of the chassis. Nevertheless, the recourse to these tests is expensive and takes much time. Thus, the use of the numerical methods leads to a better appreciation of the fast and reliable solutions. The objective of our work is to develop a numerical method based on a computer code to check the pre-dimensioning of the frame of the railway vehicles in order to prevent the preventive maintenance. The simulation includes the thickness variation and the positions of the principal elements of reinforcement of the chassis. The results of numerical calculation are compared with those obtained by experimental tests of tension and compression. The validity of our model allows building a tool for the decision on the replacement of elements who have suffered failures during operation instead of reforming the entire chassis.

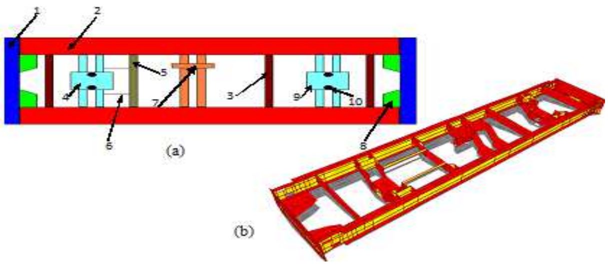
KEYWORDS: Locomotive, Châssis, Optimisation MEF

INTRODUCTION

The chassis design of locomotives is prone to several problems of dimensioning to causes of the various geometrical configurations and loading the structure. [1] Les calculs préliminaires basés sur les notions de résistance des matériaux suggèrent toujours un surdimensionnement en rajoutant par exemple un surplus dans les épaisseurs. The preliminary calculations based on the concepts of resistance of materials always suggest an over sizing by adding for example a surplus in the thicknesses. Often, after making these frames are subjected to statistical tests of tension, compression and bending, to avoid rupture [2]. However, these tests are expensive and time consuming. The use of numerical methods provides a limitation of expenditure and reducing the number of tests. Several computer codes were developed and showed their effectiveness as for the determination of the strains and the stresses in the elements of structures [3]. But often, the results given by these methods require checks on the basis of experimental test. The conformity of the results makes it possible to better determine the problems of dimensioning of the frames, particularly when, reinforcements should be brought. The error of the originators is to position cross-pieces of reinforcements in places or the constraints are found maximum, whereas really, the addition of a cross-piece causes a state of very high stresses at another unknown place, which can cause the rupture of the structure. The present work aims to study a structure of a locomotive chassis by using the computer code. This study focuses on the verification of the dimensions of the locomotive BB600H made by the Algerian company EPE. Ferrovial. The calculations simulate loads in tension, compression and bending. The results are compared to those obtained by experimentation using standardized tests. [4] The results conform to better configure frame elements by optimizing the positions and thicknesses of the reinforcing cross members.

Geometric Modeling

The geometric modeling of the structure is defined by the dimensions of the components of the existing frame structure [3]. Each element of the model was discredited into rectangular finite elements to using a computer code for finite element Figure 1b



1) Cross-Pieces of Head, before and Back; 2) Longitudinal Members, Right and Left; 3) Front, Intermediate and Back Cross-Pieces; 4) Cross Pivot before with Dimensions Locomotive; 5) Cross Pivot Postpones with Imensions Locomotive; 6) Supports Locomotive; 7) Front, Back and Side Cross-Pieces of the Gear Box; 8) Four Plate Stiffeners; 9) Cross Back Pivot; 10) Four Simple Supports
Figure 1: a) Description of the Model of the Frame of Locomotive BB600H b) Discredited Model

SIMULATION TO STATIC LOADS

The simulation is based on the static tests usually used by testing of Certification and Compliance of chassis laboratories in this simulation tests are under the action of compressive forces 2MN at buffers, compression forces in diagonal between two opposing buffers 0.5MN and tensile forces of 1MN at the coupling were repeated faithfully

RESULTS

The results of simulation relate to displacements and the constraints generated by the efforts quoted above.

4.1 Efforts Compression

During the application of a compressive force of 1MN to the level of each buffer, displacements appear and generate the bending of the chassis side girders. The displacements generated by the compressive forces are well revealed by simulation, Figure 2. It results a maximum arrow from it from -13.96 mm. All displacements are the result of constraints on the level of each element of the structure. The values of the maximum constraints obtained on the members are recorded on the level of the cross-pieces (3) before and back

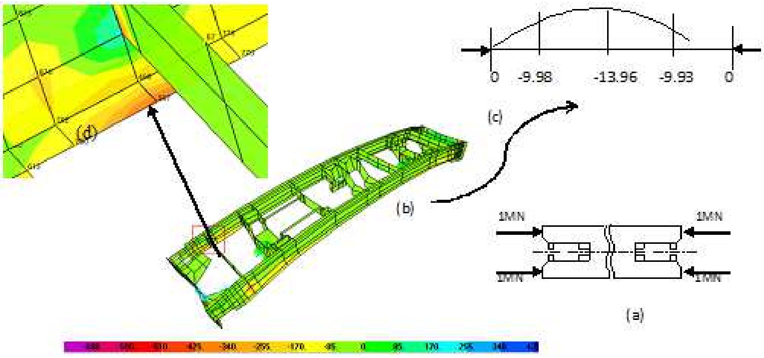


Figure 2: a) Compressive Forces on the Plugs; b) Result of Simulation; c) Maximum Member Marks with Arrows due to Compression; d) Zones with Strong Stress Concentration on the Member on the Level of the Cross-Pieces before and Back

Efforts Traction

Applying the same traction effort at coupling generates displacements and stresses as large as those observed during the compression, Figure 3. The maximum deflection reached 10.40 mm, however travel and stress values have opposite signs for the same given position.

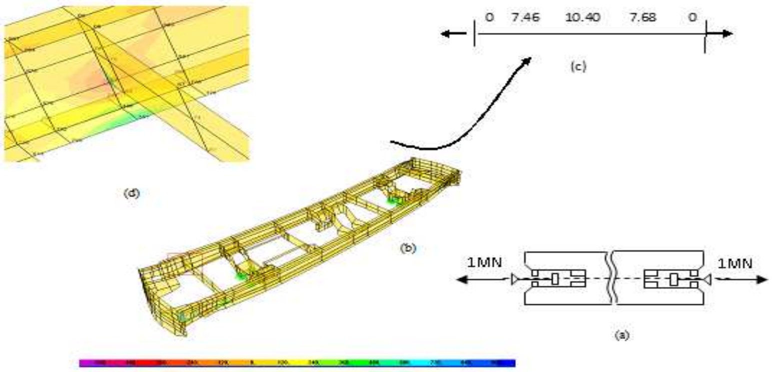


Figure 3: a) Tractive Efforts on the Atelage; b) Result of Simulation; c) Maximum Member Marks with Arrows Due to Traction; d) Zones with Strong Stress Concentration on the Member on the Level of the Cross-Pieces before and Back

Compression Forces in Diagonal

Upon application of a compressive stress of 0.5 MN at two diagonally opposing buffers, and generate displacement bending appear in the chassis longerons. The displacement generated by the compressive forces is disclosed by the simulation, Figure 4. And the chassis which had a rectangular shape prior to the force of application parallelogram deforms as a result of the deformation value is 6 mm. All movements are the result of constraints on the structure of each element. The values of maximum stresses obtained are recorded on the rails at the sleepers (3) forward and reverse.

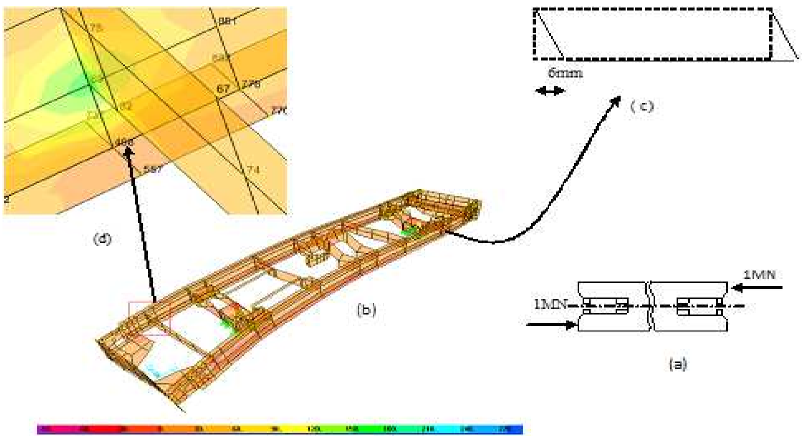


Figure 4: a) Compressive Forces on Two Opposite Plugs Diagonalements; b) Result of Simulation; c) Deformation in Parallelogram of the Frame Due to Compression; d) Zone with Strong Stress Concentration on the Member on the Level of the Cross-Pieces before and Back

DISCUSSIONS

The simulation calculation by metallic structures gives results in accordance with the experimental tests, Table 1. Table 1 shows the stress values calculated in comparison with those measured experimentally. These were conducted in the level of CME (Centre of Material Engineering) Vitry Sur Seine, France, according to the ISO 12620 standards on behalf of the public company Ferrovial Annaba, Algeria. Figure 5a shows the positions of the frame level gauges tested and Figure 5b shows the node numbers corresponding to the positions of the gauges. Compared with the experimental tests, the values of the results obtained by finite element calculation is different from that obtained experimentally in the range of 5 %. More in consideration of the structure of the frame can be obtained by simulation and the deformation stresses in any point in the structure and in the three directions.

The calculation by simulation can be used to perform verification of the structural strength so one must change the material. This avoids the use of experimental tests are expensive and time consuming. However it is still necessary to use experimentation when it is a prototype.

Table 1: Comparison between the Constraints Calculated and the Measured Stresses

Position Gauges on the Structure	Compression with 2 MN		Traction with 1 MN		Compression in Diagonal with a 0.5MN	
	Constraints (MPa)					
	Calculated	Measured [6]	Calculated	Measured [6]	Calculated	Measured [6]
0	81	117	-48.6	-21	4.28	4
1	55	52	-65	-39	12.25	10
2	-75.6	-52	79	35	-18.55	-8
3	-255	-264	350	353	-107.53	-119
4	-235	-262	208	218	-77.54	-106
5	135	133	-231	-242	141	132
6	13.73	14	-31.2	-27	22.09	21
7	-245.3	-252	188	171	-52.2	-78
8	-109	-77	40.1	39	-150.93	-177
9	-3.65	-3	3	2	29	17
10	-8.52	-1	1.5	0	66	8
11	5.75	10	-8	-3	52	28
12	-77.22	-71	48.62	47	-13.61	-13
13	45.54	54	-55.4	-28	2.8	23

Table 1: Contd.,

14	-77.23	-42	25.5	32	-5.6	-9
15	15.75	17	-28.25	-30	2.3	1
16	-262	-272	264	258	-27.75	-40
17	-249	-244	253	223	-24.5	-37
18	-240.75	-258	195.73	191	-66	-61
19	-78.61	-61	45.38	50	-12.41	-12

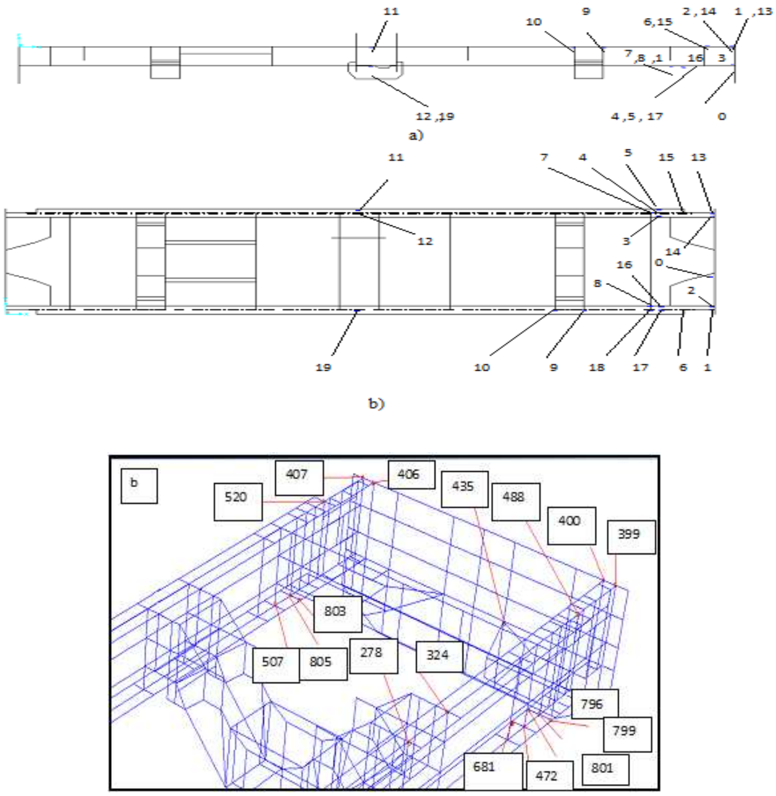


Figure 5: a) Position of the Gauges for the Stress Measurements b) Numbers of the Nodes Corresponding to the Gauges

CONCLUSIONS

Simulation by finite elements of the behaviour of the frame to the statically stresses devoted place to displacements and important constraints to the level of will place

Dedications: The authors highly make a point of dedicating this work to late professor ARRAR Mustepha, which without him; this work would not have been born.

REFERENCES

1. Martin Hienscha & all «Two-material rail development: field test results regarding rolling contact fatigue and squeal noise behaviour », Wear 258 (2005) 964–972
2. CLAUDE BATIAS ET JEAN- PAUL BAILON «la fatigue des matériaux et des Structures (2eme édition) »,1998
3. JEAN-CHARLES CRAVEUR « Modélisation des structures calcul par éléments finis (2eme édition) », 2001.
4. R. TOUATI, M. ARRAR, A. HAIAHEM «Etude du comportement de la structure du Châssis d'une locomotive (mémoire de magistère) », 2006.

5. Jean-Pierre Chenais *, Laurent Hazard, Georges Palais « Amélioration du confort dynamique des trains dans l'optique d'une augmentation des vitesses », *Mec. Ind.* (2000) 1, 123–130 2000
6. CIM Centre d’Ingénierie du Matériel, Vytry Sur Seine, France.