Modelling And Dynamic Analysis Of Catenary Maintenance Vehicle By Adams/VI-Rail

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Abstract: The railway transportation network which is become quite important in the recent times, in our country and in the world, is forced to make new investments by developing technology. Old trains give place to high-speed trains, in consequence of the railway catenary lines and the rail systems enter into a mass renovation study. During the renovation studies, it is needed the catenary maintenance vehicles which are responded the need fast, with wide working area. Until this time, while it is continuing the needs of these maintenance vehicles which are gained by import for our country, sizeable amount of currency is exported. Thanks to this research, in our country it is manufactured the catenary maintenance vehicle for the first time; and while the national capital is lying within the national borders, it is thought that it will be shaped a new work portfolio.

Index Terms: Catenary Maintenance Vehicle, Railway, ADAMS/VI-Rail, Dynamic Analysis,

1 Introduction

Since 2003, our country carries into effect important policies related to being improved the railway transportation. By renovating the existing railway technology, it has been started to passing preparation to the railway system which durables for the high-speed; and it goes into the effort to being added the new lines. The needs of maintenance vehicles increase that they will be used for the railway works which is rapidly increasing; will be able to do the catenary maintenance; fulfill the needs rapidly and are functional. Due to the fact that there are not any establishments in order to produce the catenary maintenance vehicle in our country, the demand of this intensive catenary maintenance vehicle is received by import. By reason of the fact that the sizeable amount of currency is send abroad. It is taken a decision related to be produced the catenary maintenance vehicle, it has been started to the relevant project and it has been made realization with the support of TUBITAK (Scientific and Technological Research Council of Turkey) (project no: 3140542) because of the fact that it can be provided the value added to our country and fulfilled the needs of the railway network which is improved rapidly in Turkey; and performed an instantly service.

2 ADAMS/ VI-Rail Daynamic Analysis

For examining the transport act of the catenary maintenance vehicle, ADAMS/VI-Rail software is used. ADAMS/VI-Rail is a specific area in order to be modelling the railway vehicles. MSC is worked on ADAMS. VI-Rail railway system consists of the vehicle model, rail model profile and contact elements. In the literature researches, the directing the railway vehicles is qualitied with a complicated interaction between the wheels and the rails; and in order to be allowed to analyze the dynamic act in a correct way, it is required an extensive characterization of the contact mechanism; Pombo, Ambrosio, Silva (2007). A train which works through a railway is one of the most complicated dynamic systems in engineering; Villar, B.T. (2011).

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If it is wanted to enhance the railway parameters, to illustrate, to be facilitated them for passengers, to be increased the speed or to be decreased the pollution; it is important to do a good design, simulation and analysis. It is beneficial to use a template in order to research this type of a project. It is cheaper, easier and quicker than doing with a real model. It is possible to be used a various available software for that it is done this type of design, simulation and its analysis on the railway vehicles. In this dissertation study, it is used the ADAMS/Rail. To increase the distance in between the processes of wheels design, to enhance the safety and to reduce the cost for the sum of wheel set lifetime, it is newly featured for the railway wheel abrasion and the stability, R. Lewis. For the purpose of the identified research, it is worked up an abrasion model for the integration with multi-casing dynamic simulations with ADAMS/Rail of a railway wheel kit in order to improve a profile of wheel abrasion. In this study for generating a vehicle model, it is called to the ADAMS/VI-Rail area, thereby individually saving the mounting pieces in the parasolid (*.x_t) format as a result of the constraints and references which are taking from the 3 dimensions design model, generated in the SolidWorks area. The rail profile is generated by choosing the standard UIC60 rail profile which is availably in the VI-Rail area. The wheel profile is generated according to the UIC510-2 profile in the VI-Rail area. According to the given wheel profile data (UIC 510-2 Turkish State Railways), multipoint *WRGEN contact model; an analysis model is generated by being identified in between the wheels and the rail.

3 Catenary Maintenance Vehicle ADAMS/ VI-Rail Dynamic Analysis Results, Discussion

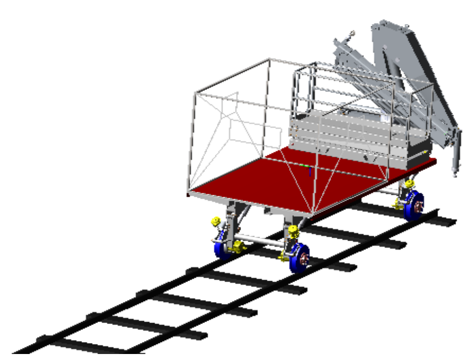

Fig. 1. *The catenary maintenance vehicle VI-Rail model*

3.1 Rigid Dynamic Analysis

For being found the minimum turning radius, it is tried different radius values by starting from 100 meters to 30 meters and the overturn radius is compressed between 31 and 32 meters. As an overturn criteria, it is taken 0 (zero) situation of the contact force in 2 wheels which lie within the cornering. The results and the figures about the 15 seconds analysis which is done on the cornering, its radius is 32 meters, are indicated as follow.

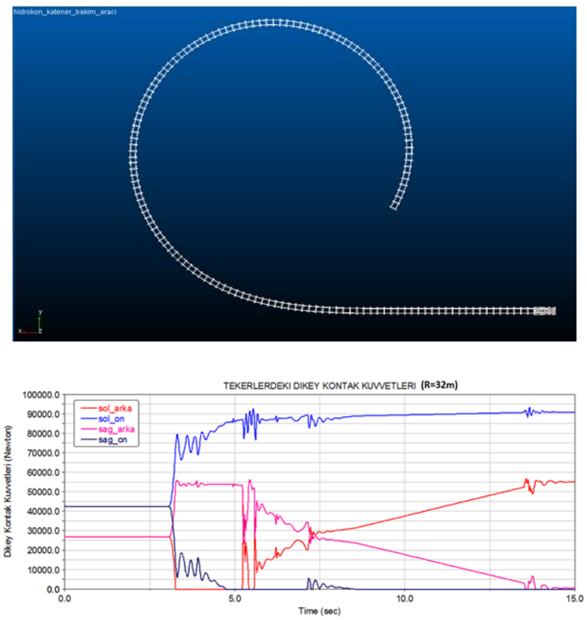

Fig. 2. *R32 Road model and wheel vertical contact forces*

3.1.1 Analytical Overturn Calculation

According to the situation that the left-side wheels lose the contact, the overturn radius value is calculated by being taken account of the weight and the centrifugal forces. For that purpose, it is taken a moment according to the bottom-right point (point A). The lateral forces which will be come to the right wheels, are excluded due to the rail profile.

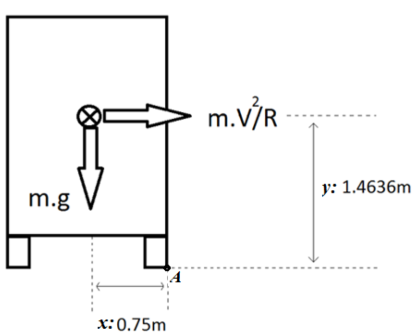

Fig. 3. *Analytical vehicle overturn radius calculation*

$$\sum M_A = 0$$

$$(m.g.x) - (m.\frac{V^2}{R}.y) = 0$$

$$(m.g.x) = (m.\frac{V^2}{R}.y) \Rightarrow g.x = \frac{V^2}{R}.y$$

$$9,81.0,75 = \frac{(13,89)^2}{R}.1,4636$$

$$R = 38,38 \text{ m}$$

The radius value of the vehicle which can turn without rollover is found 39 m as a result of the analytic calculation, is found 32 m as a result of the dynamic analysis. In the high-speed rail lines, the minimum cornering radius (curve radius) has higher values. The minimum radius value is 3500 meters in the Ankara-Konya High-Speed Rail lines. The possibility of meeting a calculated sharp cornering radius with the maintenance vehicle is quite low.

3.2 Flexible Dynamic Analysis

The flexible studies are done in order to immobilize the locations and the values of the stresses that are occurred as a result of forces arising on related element during the dynamic analysis. During the cornering analyses, the flexible by considering the stress distribution occurred on the axle set, in order to comment about the durability of axle set by reading the maximum stress value, the flexible cornering analysis has been done on the cornering which has 32 meters radius (R32). The finite element model is set, the modal analysis is done. *.mnf offset which is obtained by changing the resolver parameters, is taken to the /VI-RAIL area and it is created in the flexible element dynamic analysis model by linking the rigid elements with the relevant joints.

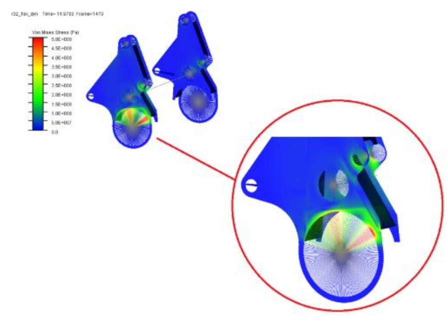

Fig 4. *Road with the R32 m radius front axle stress distribution and scale*

It is encountered the highest stress values in which the wheels are linked to the axle set. These values are 480 MPa for 32 m. When the rigid dynamic analysis result is examined, it is provided for that it can be gone in safe without overturning in the maximum speed, 50 km/hour of the vehicle. When the flexible dynamic analysis result is examined, the read axle stress value is under the yield stress value of the used material (Weldox 700). Because of that there is not a danger of plastic deformation (permanent deformation) in the material.

$$s = \frac{\sigma}{\sigma a}$$

$$s = \frac{700}{480} = 1{,}458$$ has safety coefficient.

4 Conclusion

In this study, the model which is the most real-like mathematical model of the catenary maintenance vehicle which is manufactured for first time in Turkey has been set via ADAMS/VI-Rail software; the rigid and the flexible dynamic analyses have been done by giving the required constraints. The purpose is that the maintenance vehicle which is manufactured in only a few countries in the world, is manufactured in our country and it is verified the design by making real the dynamic analyses. ADAMS/VI-Rail software is generally used in order to be modelling and analyzing the railcar and the classical railway transportation vehicles like a train. The main subscription of this study for the literature is that a railway vehicle which is a special design is served as a model by modelling by contrast with the common use.

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REFERENCES

[1] Joao Pombo, Jorge Ambrosio & Miguel Silva (2007), "A new Wheel-rail contact model for railway Dynamics", Vehicle System Dynamics; 45:2,165-189.

[2] Villar, B.T. (2011), "Railway Design, Simulation and Analysis by ADAMS/Rail Software" Master thesis.

[3] R. Lewis, M. Cavaletti, R.S. Dwyer-Joyce, A. Ward, S. Bruni, K. Bel Knani, P. Bologna "Railway Wheel wear predictions with Adams/Rail" (Europan Community funded Project HIPERWheel)