SPRING PARAMETERS EVALUATION OF 6X6 OIL PALM FRUIT BUNCH TRANSPORTER VEHICLE SUSPENSION SYSTEM

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ABSTRACT: The new development of 6x6 oil palm fruit bunch transporter vehicle requires new specifications of all vehicle parameters including the suspension system. For the suspension system of this type of vehicle, the main focused component is the spring due to the specific functions of the vehicle. It is because, this vehicle is mainly used to carry heavy load and drive on uneven and hilly road surface, which requires high ground clearance. The type of suspension used in this vehicle was MacPherson strut and equipped in all 3 axles. Because of that, the aim of this study is to evaluate the spring parameters based on the vehicle performance requirement. It was carried out using finite element analysis (FEA) to determine the stress and maximum deflection. The results showed maximum stress of 1.04 GPa for front spring and 1.24 GPa for middle and rear springs. These values were well below the tensile strength of chosen material, which was 2.45 GPa. For the maximum deflection of the springs, the results also showed the values that able to meet performance requirements. The front spring recorded maximum deflection of 81.3 mm and the middle and rear spring recorded maximum deflection of 84.5 mm. Based on these results, it can be concluded that the proposed spring parameters are suitable to be used in the new design of 6x6 oil palm fruit bunch transporter vehicle.

KEYWORDS: *Suspension System; Spring Design; 6x6 Transporter*

1.0 INTRODUCTION

The new development of 6x6 oil palm fruit bunch transporter vehicle requires new design of vehicle subsystems (Deraman et al., 2013; Md. Saad et al., 2016a). This includes the sizing of suspension system component parameters, particularly the spring. This process is required in order to fulfil the specific function of this vehicle. Even though the main purpose of the suspension system is to absorb any disturbances from road surface, but in this specific case, it is concentrated on handling the heavy load of the vehicle (Md. Saad et al., 2016b).

In general, two main specific parameters of suspension system are damping, which is related to absorber and stiffness, which is related to spring (Md. Saad et al., 2016a). But, for palm oil fruit bunch transporter vehicle, the focused parameter is the spring stiffness. Apart from withstanding the heavy loads, this vehicle also requires high ground clearance especially when moving on hilly road surface, which is common in the oil palm plantations. These two main functional requirements are related to the main function of suspension spring.

Because of that, the aim of this study is to evaluate the spring parameters of suspension system particularly in handling the heavy load and providing high ground clearance.

2.0 RESEARCH METHODOLOGY

This new transporter vehicle was designed with 3 axles that using MacPherson Strut type of suspension. The initial phase of this study was determining the spring performance requirements. The weight acting on the spring was determined by load distribution of the vehicle.

On the other hand, the maximum deflection was based on the maximum ground clearance of the vehicle. Details of the parameters are listed in Table 1 below.

Table 1 Spring Performance Requirements

Parameters	Performance Requirements		
	Front Spring	Middle Spring	Rear Spring
Weight (N)	2423.07	6146	6146
Max Deflection, δ (mm)	90.50	89.89	89.89

Both of these parameters were calculated theoretically. It became the baseline values for the suspension analysis. The chosen material for the spring was Music Wire ASTM A228. The properties of this material are listed in Table 2 below.

Next, the new parameters of spring were analyzed using finite element method.

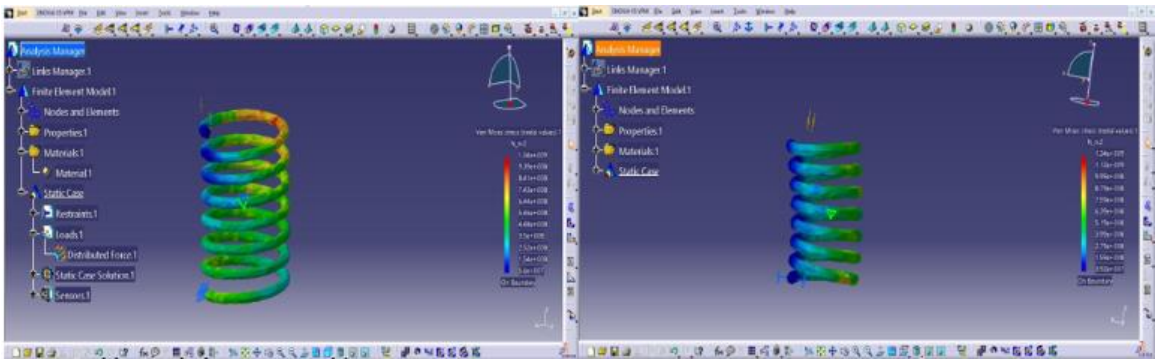
Table 2 Mechanical Properties of Music Wire ASTM A228

Properties	Music Wire ASTM A228
Modulus of Elasticity (GPa)	190
Modulus of Rigidity (GPa)	79.2
Shear Strength (MPa)	1470
Ultimate Tensile Strength (MPa)	2450

3.0 RESULTS AND DISCUSSION

Figure 1 below shows the Von Mises stress for the springs at all 3 axles based on the finite element analysis using Catia V5. The maximum stress for front spring was 1.04 GPa and for middle and rear spring were 1.24 GPa. Based on these results, these values are much lower that the tensile strength of the material, which is 2.45 GPa.

The higher stress on the middle and rear springs are due to the major load of the vehicle, which is the oil palm fruit bunch that is located at the middle and rear axle. As a whole, it can be said that this springs are able to withstand the maximum load of the vehicle without fail due to stress.

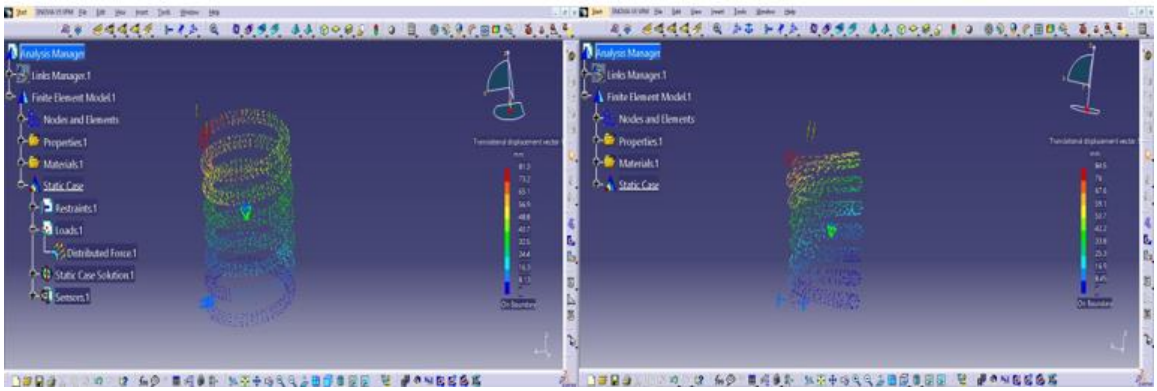


(a) (b)

Figure 1: Von Mises Stress for (a) Front Spring and (b) Middle and Rear Spring

Figure 2 below shows the maximum deflection of the spring based on finite element analysis. The recorded maximum deflection for the front spring was 81.3 mm and for the middle and rear spring were 84.5 mm.

These values also show that the spring design parameters are able to meet the required spring performance. It indicates that the maximum suspension travel still does not exceed the ground clearance of the vehicle.



(a) (b)

Figure 2: Deflection for (a) Front Spring and (b) Middle and Rear Spring

4.0 SUMMARY

The aim of this study is to evaluate the spring parameters for the suspension system that is going to be equipped in the new 6x6 oil palm fruit bunch transporter vehicle. It was focusing on the McPherson strut type of suspension that were attached at 3 axles. Theoretical calculation was carried out to determine the spring performance requirements. The main parameters under investigation were the stress and maximum deflection of the spring under maximum vehicle loads. Finite element analysis by using Catia V5 was utilized to obtain these parameters. The results showed maximum stress of 1.04 GPa for front spring and 1.24 GPa for middle and rear springs. These values were well below the tensile strength of chosen material, which was 2.45 GPa. For the maximum deflection of the springs, the results also showed the values that able to meet performance requirements. The front spring recorded maximum deflection of 81.3 mm and the middle and rear spring recorded maximum deflection of 84.5 mm. Based on these results, it can be concluded that the proposed spring parameters are suitable to be used in the new design of 6x6 oil palm fruit bunch transporter vehicle.

5.0 REFERENCES

Deraman, M.S., Shuib, A.R., Mohd Ali, Z., Mohamad, A. and Md Hasan, H. (2013). Ryno : A Multipurpose Wheel Type Transporter For Oil Palm Activities On Undulating Terrain And Soggy Areas. *MPOB Information Series.*

Md Saad, A., Salim, M.A., Harun, M.H., Mansor, M.R., Akop, M.Z. and Musthafah, M.T. (2016a). Influence of Transient Response on Suspension Damping. *Proceedings of Mechanical Engineering Research Day*. pp. 23-24.

Md Saad, A., Salim, M.A., Harun, M.H., Mansor, M.R., Akop, M.Z. and Musthafah, M.T. (2016b). Influence of Tire Stiffness and Sprung Mass on Ride Quality. *Proceedings of Mechanical Engineering Research Day*. pp. 17-18.

Shuib, A.R., Yahya, A., Wan Ismail, W.I., and Desa Ahmad, D. (2009). A Six-Wheel-Drive Transporter for Oil Palm Fresh Fruit Bunches Evacuation. *MPOB Information Series*. pp.1-4