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Dynotest Design Analysis for Electrical Converted Vehicles

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Abstract: The study comprises Dynotest design and analysis to measure torque and horsepower. Basically, a dynotest carried out by apply certain load to the axle of a combustion motorthrough the braking mechanism of its crankshaft. Due to the high price of a Dynotest unit in the market, it is relatively difficult for a developing institution to own it on their site. The study target to design a simple and good accurate Dynotest within a reasonable price. The study used a common standard method for design analysis which rely on function and structural approach. Functionally, Dynotest is designed to be used to an ouput of an electical motor. Loading on motor shaft was done by disc brake braking mechanism. Structurally, Dynotest was designed to use rollers. As a main component, its mounting construction is connected to a motor to generate electrical power. Power transmitted from the motor to Dynotest through a center joint shaft, torque measured by load cell while the rotation of shaft itself counted by a digital tachometer. Test result show that electricity was produced from the simple construction and Dynotest functioned well in measuring it. Measurement data of roller support shaft performance showed a motor torque performance curve which are similar with the typicals of similar Dynotest. Construction Test done by applying Solid Work software analysis to some components partially on rollers and on the construction assembly as a whole unit.

Keywords: Roller; Dynotest; Listrik; Assembly

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1. Introduction

Officially stated in RUEN (Rencana Umum Energi Nasional/General Planning of National Energy) 2020, Indonesia targets to build 2.200 unit of electric/hybrid 4 wheels vehicles dan 2.1 million unit of those in 2025. This RUEN is a continuance of Peraturan Presiden (PERPRES) Nomor 55 Tahun 2019 [1]. "Percepatan Program Kendaraan Bermotor Listrik Berbasis Baterai (Battery Electric Vehicle) untuk Transportasi Jalan.

The national position of our research itself is now to continue the conversion program to have an electric vehicle with manual transmission, which is more user-friendly and effective in urban surroundings [2]. Already achieved the most suitable gear ratio to fit a transmission system for a certain speed. Further analysis has been taken to find the optimum motor performance in serving various field [3]. Classically we knew that there are efficiencies among components in a conventional vehicle, such as transmission, axle, and differential, but in an EV (electrical vehicle) the efficiency of a transmission unit is regarded ideal even constant [4]. An EV performance is calculated by its speed and working threshold variables, which are rolling resistance, air friction coefficient, gradient resistancy also its inertia [5].

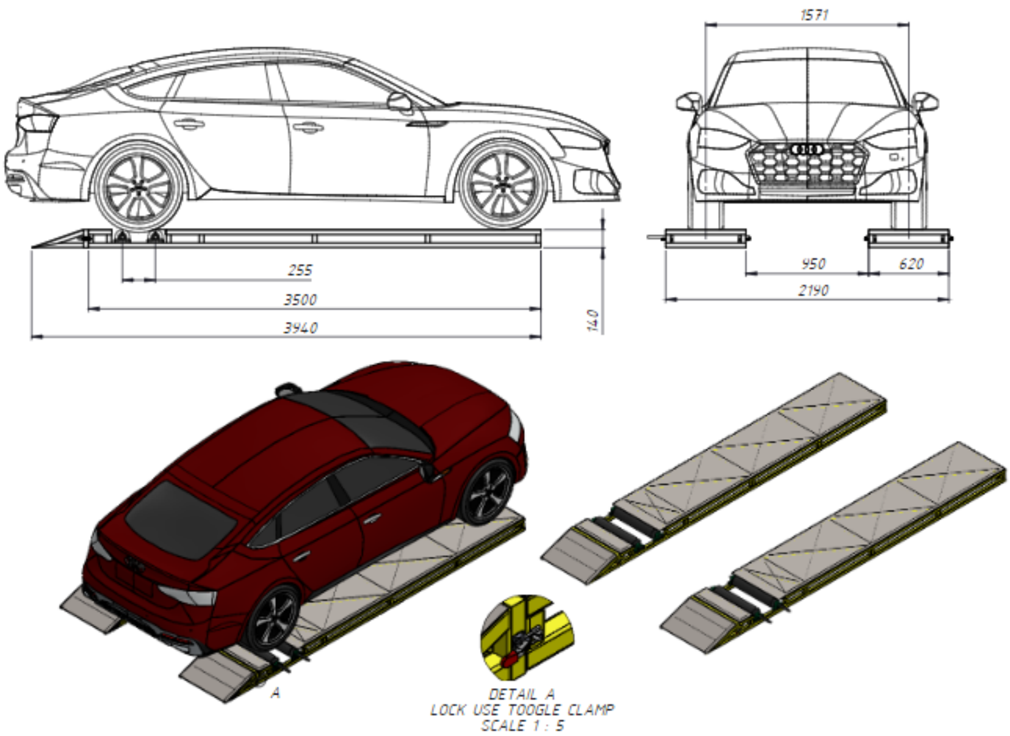


Figure 1. *Design Model of Dynotest Unit* [7]

Characteristics of a motor represemted by a chart describing the relation between power, torque etc versus rpm of a constant throttle openings. There we can plot the traction force (Pt) vs vehicle speed of some certain speed rates. Then we can determine the torque value for certain rpm by using Eq. 1 [8].

T = 9549 (1)

where:

T is the Torque of the motor (N m)

N is Work of the motor (kW) in (rpm)

Dynotest is a measuring tool for torque result and horsepower. In advance automotive fields, many major companies apply the test in its manufacturing. The machinery will always grow and develop every time and there will always efforts to improve performance of components in many aspects such as speed, comfortability and cost savings. A torque and horsepower of a machine can be easily calculated by a dynotest apparatus. [3].

The scope of the study was to perform a series of dynotest of a converted EV through the measurement of rpm, torque, and horsepower of its prime mover motor. The test done under different gear positions so that from torque and horsepower data gained the optimal conditions of every position can be plotted. The test revealed some areas where gear shiftment did not trigger a decceleration and promoted a motor efficiency in an EV [8]. Research development and modelling that have been done in the study can be utilized further to have more effective and efficient value.

2. Materials and Experiment Methods

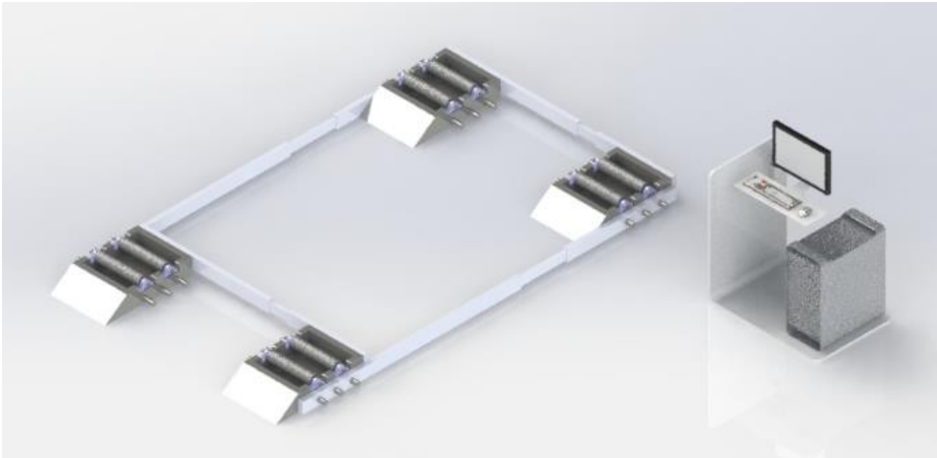


Figure 2. Dynotest installation unit

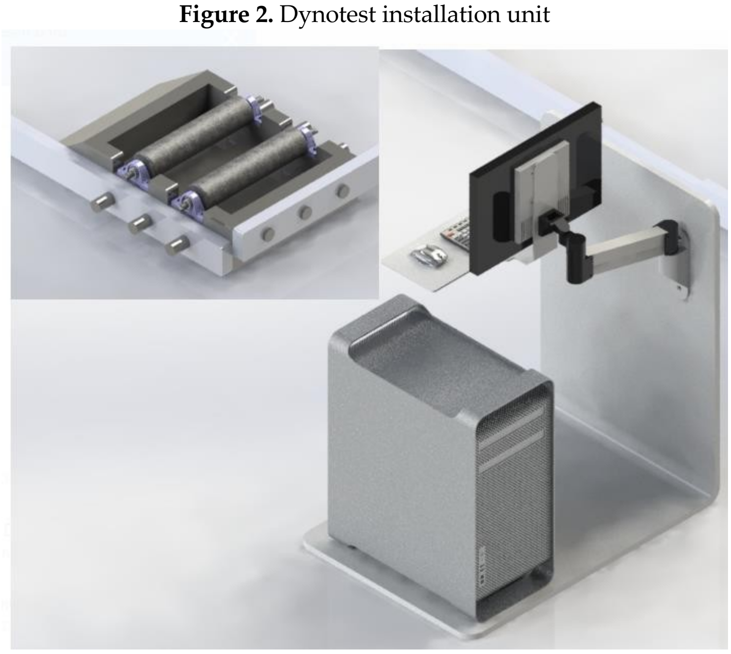


Figure 3. Dynotest Installation

Followings are steps in collecting data of torque and horsepower result. Initially the dynotest unit have to be calibrated within braked condition. Mark the value in multitester used as a reference readings. After calibrated, put the vehicle on the dynotest chasis.

Due to too many equiptment installed and all must work in one integration without room of failure, prior to the test partially the system itself has to be tested. This to ensure every part functioned well before interface it with the others. Test the EV unit on the planned parameters. The phase of integration, improvement and testing are the longest phases, actually unlimited for the improvement of EV in Indonesia. The result of any study will be a good startup for developing further.

Speed of the test is decided as 80 km/hour. The speed is become the profile for a converted EV with the specification frontal area approximately 4.16m2, aerodynamic friction (Cd) 0.5328 and rolling friction 0.002. The vehicle was tested without passenger load and without activating secondary function, therefore only main motor is switched on. An EV is driven by 1 (one) main 3 phase motor

Tabel .1 Test Vehicle Specification

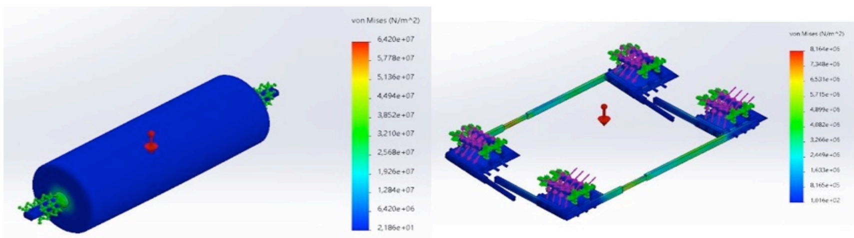
Dimension

Overall Length (mm)	4.110	Rear Tread (mm)	1.465
Overall Width (mm)	1.655	Ground Clearance (mm)	180
Overall Height (mm)	1.600		
Wheelbase (mm)	2.525	Overhang Front (mm)	630
Front Tread (mm)	1.460	Overhang Rear (mm)	915

3. Results and Discussion

Data Analyze of Dynotest Software Simulation.

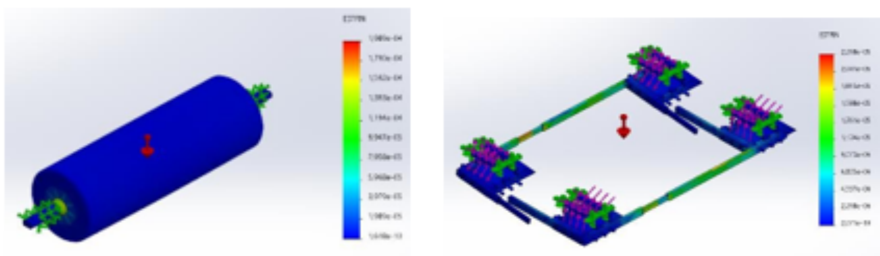
Horsepower measurement (HP) of each speed condition and each gear reveal that the value of HP of 1st gear has lower resistency than those of the 5th gear, with the biggest resistency held by 4th gear. Torque measuremement of each speed also showed that the torque when 1st gear is applied, is lower than the torque when 5th is applied. Optimum condition reached when 4th gear is used.



Stress of Single Roller *Stress in Assembly*

Figure 4. *Stress Analysis*

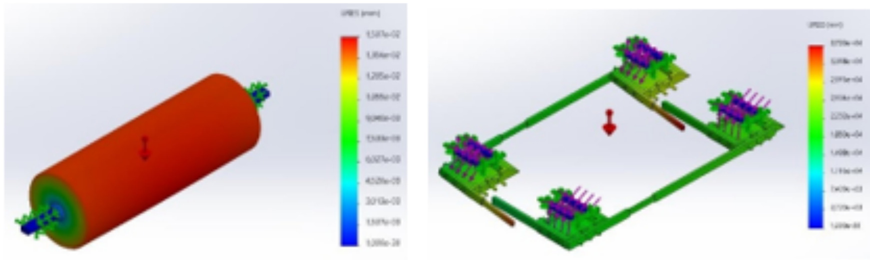
Figures above describe stress analysis of a dyno test machine. The left is the stress distribution of a roller while the right one is the stress analysis of a complete set of dyno assembly. There are 4 (four) color: blue, green, yellow and red. Blue represent the lowest stress while red the highest one.



Strain of Single Roller *Strain in Assembly*

Figure 5. *Strain Analysis*

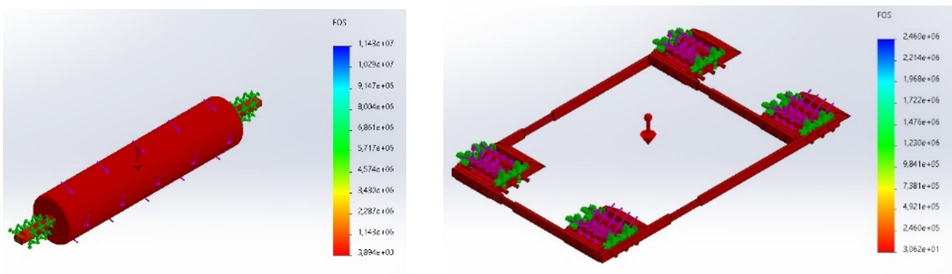
With the same color configuration, Figure 5 representing strain analysis. Area with biggest strain is the roller shaft (left) and the roller bar connectors (right)



Displacement of Single Roller *Displacement in Assembly*

Figure 6. *Displacement Analysis*

The biggest displacement is the surface of single roller (left drawing), front connector for assembly.



Safety Factor of Single Roller *Safety Factor in Assembly*

Figure 7. *Safety Factor Analysis*

Safety factor value of 3,89e+00 single roller and 3,062e+01 for the assembly, signify the dyno test machine is safe to be fabricated. For the optimum, there are 2 possibilities by applying 2 (two) gear combination to have optimum set of horsepower, torque, and rpm.

4. Conclusions

- Need a sustainable regeneration to have a continuance of the research.
- Combination of speed, acceleration, deceleration also kerbs will give different phenomenon of force produced.
- Theoretically, the average output is higher than the the average of actual input of a motor. This should be investigated in a further study.
- The study, research, improvement, and development of EV is a very strategic to continue.

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