CHASSIS DYNAMOMETER TO ANALYSE PERFORMANCE OF ELECTRIC TWO WHEELERS (ETW)

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INTRODUCTION

In recent years, electric motorcycles are emerging as one of the alternative to improve sustainability of transportation energy and air quality especially in urban areas. Although electric motorcycles are environmentally friendly, they underperform compared with gasoline motorcycles in many respects, particularly in speed and cruise distance between refueling and recharging.

Currently, dynamometers for vehicles are generally divided into chassis-type and engine-type dynamometers. In a chassis-type dynamometer, the rear tire will make contact with the rollers. The rollers will be coupled directly to the dynamometer in order to simulate the load on the engine. In the case of an engine-type dynamometer, it is quite inconvenient to disassemble a two-wheeler electric motorcycle before it can be tested on an engine-type test platform.

This project is aimed to develop a chassis dynamometer that can be used to measure mechanical power, speed and torque, and provide a controllable load to the ETW being tested. The prototype of chassis dynamometer for ETW had been developed and performance of the chassis dynamometer was tested by using an electric bicycle to emulate the basic performance requirements of an ETW which consist of maximum speed, driving range and acceleration.

DATA ACQUISITION

Speed and weight of electric bicycle plus load and roller are required to determine the power and torque curve. Speed data of roller are collected by using an Arduino (MEGA) with the aid of rotary encoder. The rotary encoder determines any displacement, velocity, acceleration, or the angle of a rotating sensor.

A typical rotary incremental encoder consists of a light-emitting diode (LED), a disk, and a light detector on the opposite side of the disk. The disk, mounted on the rotating shaft, has patterns of opaque and transparent sectors coded into the disk.

As the disk rotates, the opaque segments block the light and, where the glass is clear, light is allowed to pass. This generates square-wave pulses, which can then be interpreted into position or motion and saved as speed data. The speed data obtained through Arduino then will be extracted into Microsoft Excel and it will be used to determine the torque and power.

The generated graph of torque is basically the product of moment of inertia of the roller times the acceleration obtained from the speed data plotted against speed. Meanwhile, for the power curve is plotted against the same speed and the values of power is calculated by multiplying the torque with the speed. This is conducted by using MATLAB-based automated program.

PRODUCT DEVELOPMENT

The chassis dynamometer was designed to test performance of ETW of multiple types and sizes. The front wheel clamp is adjustable and the rollers' size is adequate for all types of ETW.. The chassis dynamometer platform was designed by using Solidworks software. The analysis on safety and overall rigidity of the chassis dynamometer platform were also conducted by using Solidworks. The chassis dynamometer platform was designed to be portable. ASTM A36 steel was chosen as the material for the platform based from the analysis results. Rollers were made from carbon steel.

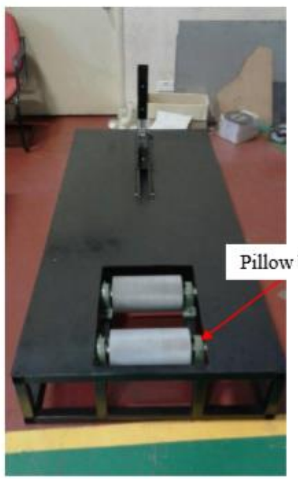

Fig. 1: Pillow block bearings and rollers setup

Fig. 2: The platform of the chassis dynamometer

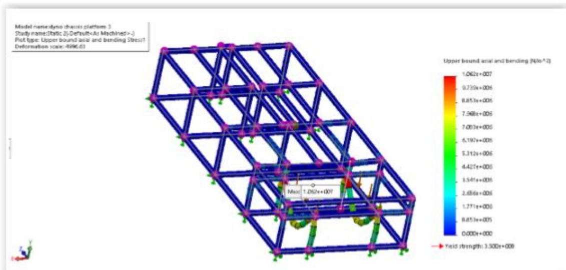

Fig. 3: Bending simulation result for AISI 1020, cold rolled steel

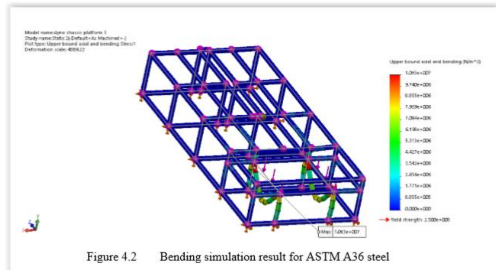

Fig. 4: Bending simulation result for ASTM A36 steel

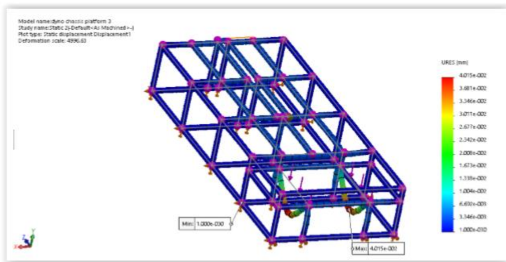

Fig. 5: Displacement result for AISI 1020, cold rolled steel

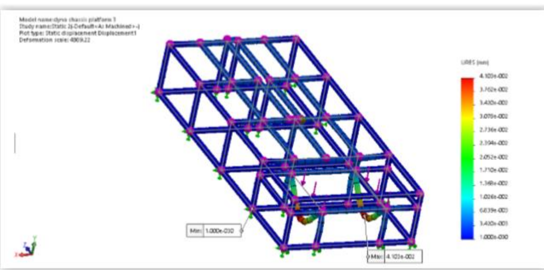

Fig. 6: Displacement result for ASTM A36 steel

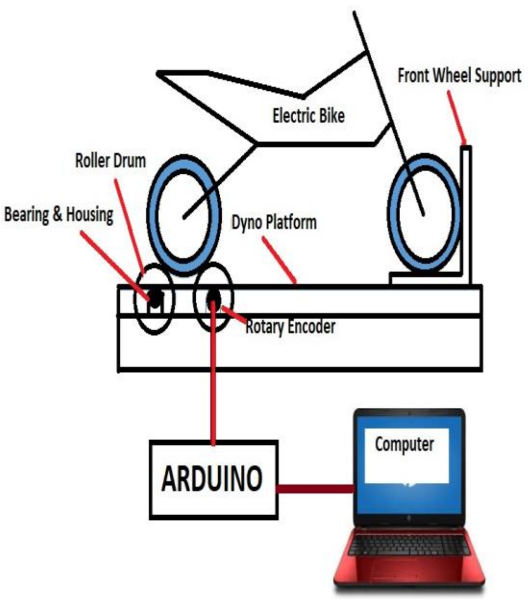

Fig. 7: Performance test setup

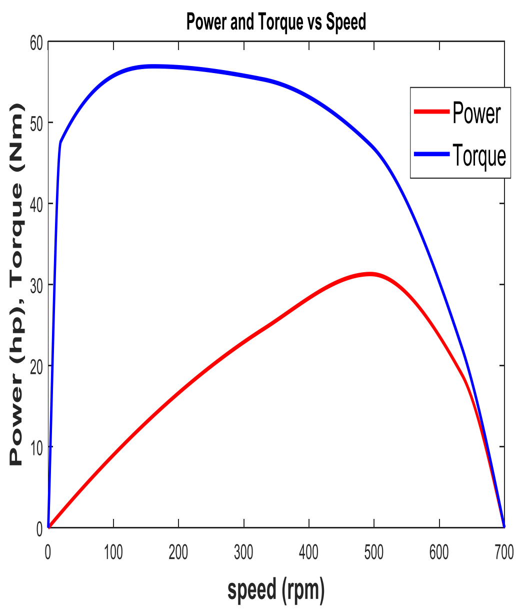

Fig. 8: Power and torque vs Speed

Table 1: Analysis results of chassis dynamometer platform

Material	Results	Yield Strength	Summary	Safe
AISI 1020 cold rolled steel	Stress = 1.062 X 10^7 N/m^2 Deformation = 4.015 X 10^{-2} mm/mm	3.5 X 10^8 N/m^2	$\sigma_{ind} < \sigma_{allow}$	Yes
ASTM A36 steel	Stress = 1.063 X 10^7 N/m^2 Deformation = 4.103 X 10^{-2} mm/mm	2.5 X 10^8 N/m^2	$\sigma_{ind} < \sigma_{allow}$	Yes

MARKETABILITY

1. Small and Medium Motorcycle workshop
2. Motorcycle Manufacturing Industries
3. Motor GP Racing Team
4. Public or private educational institution

COLLABORATOR

UMP HOLDING SDN. BHD.

ACHIEVEMENTS

GOLD MEDAL, CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION, 2018, UMP

PATENT

PATENT FILLING STATUS: PENDING, DATED: 09 APRIL 2018