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Characterization of dynamometers for vehicular verification tests, complying to the Standard nom-047-semarnat-2014

ABSTRACT

This report provides an analysis of the obtained results from the characterization process of the chassis type dynamometer at Mexico's National Center of Metrology and a proposal for a portable dynamometer calibration device. The parameters of interest for the characterization process were the linear and angular velocity of the dynamometer's rollers, the deceleration rates at different brake loads, the braking force profile and its derivatives such as torque and power, and the equivalent inertia and equivalent moment of inertia of all the rotating components of the system.

A laser surface velocimeter (LSV) was used to obtain linear velocity profiles of the rollers, while a tachometer was implemented to obtain the angular velocity profile. The braking force profiles were obtained by using the strain gauge already installed on the dynamometer. All measurement data was processed using MATLAB to obtain the acceleration, torque and power profiles.

Results from the data analysis shows that the software, which controls the dynamometer of interest, does not behave properly, especially during the brake application. A proposal for a portable dynamometer calibration device using a dynamic torque sensor installed on a motor vehicle was concluded to be the most viable option for CENAM.

OBJECTIVES

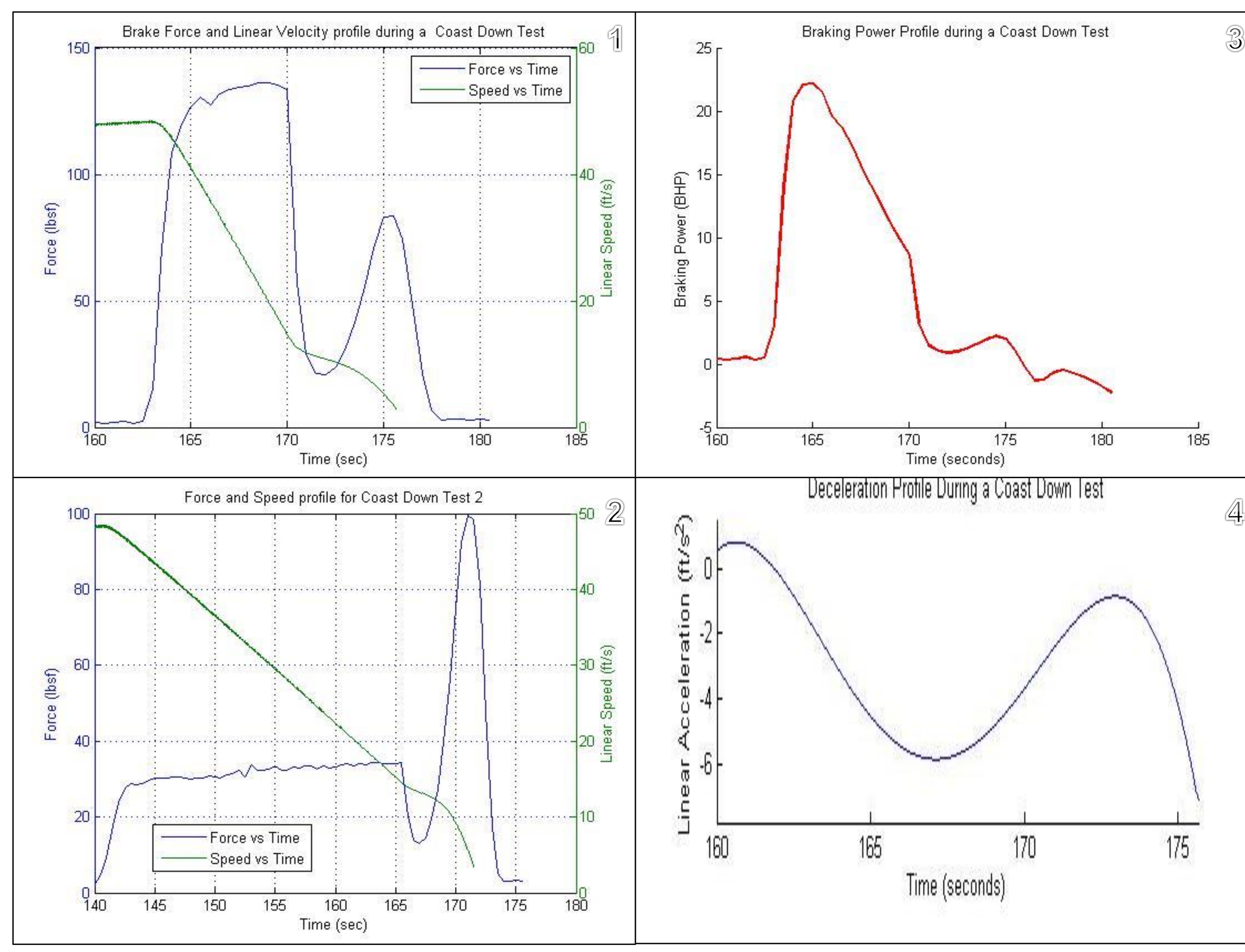
To characterize the chassis dynamometer at Cenam. To propose a design for a portable device as well as a process for performing calibration tests.

$$M_e = \frac{47.48 * I * (\omega_1 - \omega_2) * \omega_q}{(V_1^2 - V_2^2)} * 2.205$$

Equation used to measure equivalent inertia

BACKGROUND

In Mexico, the emissions generated from the daily use of motor vehicles contribute to 22.2% [Instituto Nacional de Ecología y Cambio Climático] of the overall emission of Greenhouse Effect Gases to the atmosphere. Therefore, dynamic vehicular emission's verification tests that comply with the specifications stated in the Official Mexican Standard NOM-047-SEMARNAT-2014 will be implemented as a method to control emissions of vehicles that were made in 2006 and before. To properly implement said testing procedures, chassis dynamometers, which are devices used to apply a simulated load and measure the power of the engine of a vehicle, will run and measure the speed and load based on the weight of the vehicle.



Graph 1 shows the break force and linear velocity for coast down test 1

Graph 2 shows the force and the linear velocity for coast down test 2

Graph 3 shows breaking power

Graph 4 shows the deceleration profile

METHODS AND MATERIALS

The parameters of interest for the characterization process were linear velocity and acceleration, angular velocity and acceleration, brake force, brake power, brake torque, equivalent moment of inertia and equivalent inertia. For this, the dynamometer was set up to run up to 56 km/hr and then have the brake load applied to the system, 140lb and 70lb for coast down test 1 and 35lb and 17.5lb for coast down test 2.

Determining velocities and acceleration:

- To obtain the linear velocity of the rollers, a laser surface velocimeter was implemented.
- An optical tachometer, was used for measuring the angular velocity of the system.
- Using a MATLAB script, we approximated a polynomial from the velocity data obtained, and derived it to obtain the deceleration curve.

Determining the brake force, torque and power profiles:

- The brake force measurements were obtained by using the strain gauge installed by default.
- The data obtained from the force measurements was processed using MATLAB to obtain the torque and power profiles.

RESULTS

- It was found that the dynamometer reaches its max velocity after 142.2 seconds (in average) have passed since the initiation of the tests.
- During coast down test one, the brake reached its target load value of 140 lbs for the high speed window and 70 lbs for the low speed window.
- During coast down test two, the brake reached its target load value of 35 lbs for the high speed window, but did not apply the target load of 17.5 lbs for the low speed window, instead it applied the same 70 lbs of load, as the first coast down test.
- The braking power ranges from 0 to 22 Hp with only 20 percent of its maximum capacity.
- The deceleration rates vary depending on the brake force applied.
- An equation for determining the equivalent inertia of all the rotating components was derived using the classic torque equation in a rotating system, and a formula that is used to determine parasitic losses in chassis type dynamometers.
- The proposed design for the portable calibration device, consists of an instrumented Toyota Corolla with the dynamic torque sensor Kistler RoaDyn P106.

CONCLUSIONS

- Newton's second law can be used to find the inertia equivalent.
- From the power absorption graph it can be concluded that the power is within the limits specified by the standard.
- From the speed and force graph of the coast down test the loads were different between the high and low window so it can be concluded that the software was not setting a constant load.
- The dyno calibration device using a car will be able to find accurate readings for torque and linear speed.

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