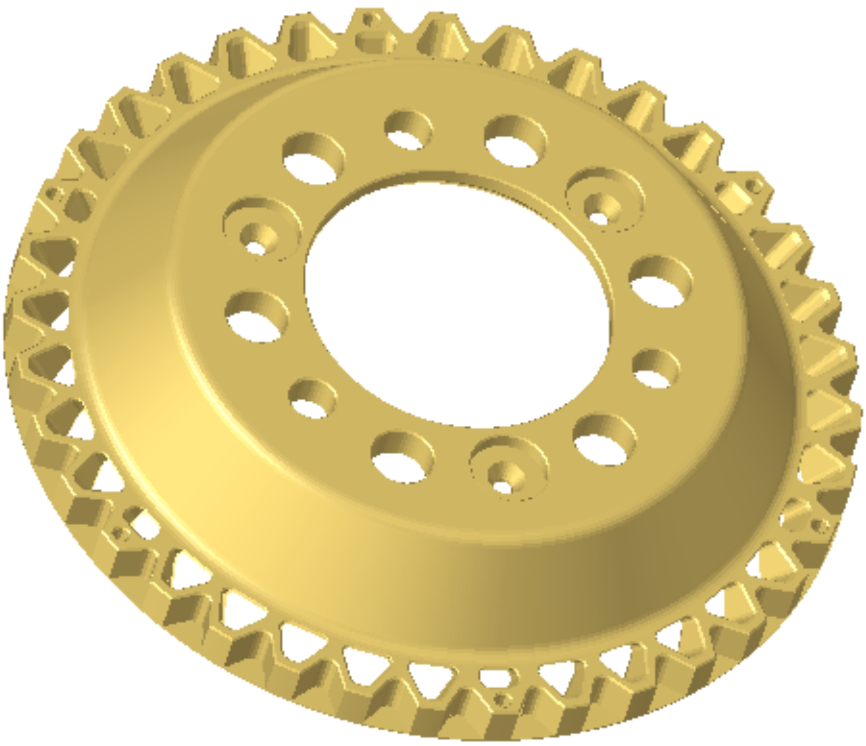
Motorvehicle University of Emilia Romagna
Advanced Automotive Engineering – Racing Car Design

DYNAMIC TESTING OF A LMDh VEHICLE BRAKE BELL



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Introduction

The Dynamic Testing of Vehicle course deals mostly with the techniques dedicated to analysing and managing vibrations in mechanical systems and, in particular, on vehicles.

Within this context, we can identify three main sources of forcing of oscillatory movements and loads: the road profile, forces arising from partially unbalanced rotations of the wheels or components of the powertrain, and intrinsic oscillations caused by combustion engines. The latter are significantly reduced or absent in the case of electric motors.

Vibrations play a critical role in the mechanical design of vehicles and cannot be disregarded. They must be carefully analysed to prevent performance losses, such as uneven tire contact patch loads, and to ensure safety, which depends on the reliability of components subjected to variable loads. These loads are characterized by fatigue and, in some cases, by high accelerations near resonance frequencies.

This project focuses on the analysis of a specific component, the brake bell of the Cadillac LMDh prototype racing in the World Endurance Championship. The objectives of this study are to identify experimentally the natural frequencies of the component and the relative mode shapes with dedicated measuring instruments.

Component description

A brake bell housing main purpose is to connect the brake disc, which is a carbon-based component with almost a perfect disc shape, to the wheel hub, transmitting the torque generated by the calliper on the disc to the hub and ultimately generating a decelerating force at the contact patch. Considering the mass of the vehicle and the relevant amount of available grip, the component is subjected to high loads, representing a critical safety component which has to guarantee the functionality of the car braking action.

To accommodate thermal expansion and manage tolerance chains, the coupling between the callipers, pads, and disc must be carefully designed. In road cars, this is achieved using a floating-callipers configuration. However, in race cars, a floating disc setup is preferred, as it enhances stiffness while maintaining effectiveness. This configuration better suits the carbon material used for racing discs, which, unlike cast iron, are more brittle and unsuitable for direct bolted connections to the hub.

The bell also provides a good solution for disc cooling, and this is suggested by the shape of the outer ring of the component which has visible channels for radial air flow. The connection between the bell and the disc is achieved through a splined interface, while the bell is joined to the hub using pegs. These pegs are designed to bear shear loads and transmit torque, with screws providing axial positioning.

The material chosen for the component is a titanium alloy, more specifically Ti6Al4V, which has the following relevant properties:

- Density: 4.7 kg/dm^3
- Young modulus: 112 GPa