An Electro-Mechanical Brake to replace pneumatic brakes

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ABSTRACT
Vienna Engineering (VE) is working since approx. 2008 on an Electro-Mechanical disc Brake (EMB) for passenger cars and special applications like elevators. It is based on eccentrics that press the pad to the disc and uses a highly nonlinear actuation snail that makes very fast progress at the beginning when the force is low and turns to high force at full braking. With this high non-linearity (that is represented in the actuation snail curve) it reaches high brake torque in very short time, e.g. 50 ms. The VE-EMB can also be spring actuated to engage at power-off.

This paper discusses how the VE-EMB can replace pneumatic brakes for Commercial Vehicles (CV) and railway brakes. Air brakes need an expensive compressor that increases fuel consumption, causes weight and needs room. Some EMBS (e.g. the VE-EMB) are very fast in actuation to reduce stopping distance at emergency braking. For certain CVs it makes economic sense to use hybrid drive: city-buses can save a lot of fuel only by storing little energy, because the permanent stopping can easily be stored in a low-capacity battery or in a small and cheap flywheel. Garbage collection is an example where only a relatively small battery is needed for making little travel and powering the garbage pickup, avoiding diesel consumption, pollution and noise.

At all these hybrid applications the so called “blending” must be solved: When speed drops the generator produces less to no electricity and this declining brake torque must be replaced exactly with e.g. the friction brake. An EMB can produce precise brake torque which might be harder to adjust with pneumatics. CVs often need very individual and hence expensive piping, EMBs use the wire harness. These advantages of EMBs over air brakes are discussed in this paper by calculations based on the VE-EMB.

The research objective of this work is to derive CV, railway and elevator versions from the passenger car EMB and to show their technical data (actuator power and torque, actuation and ABS timing) and to compare it with typical data of pneumatic brakes.

The EMB simulation is always on top of development methodology. It uses realistic and calibrated values of elasticity of mechanical parts (caliper, pads, bearings, etc.) to calculate actuator torque, power, timing and actuation snail shape and auto-engage spring and cam. These values are used for CAD and the final drawing is used for CNC production.

The results of the study are an elevator-brake that exists as optimized hardware and goes to a test elevator, a railway brake in CAD that fulfills the “all electric metro” requirements (normal force, actuation timing, packaging and power consumption) and a CV brake with technical data from simulation. These values are compared with conventional brakes. The limitations of the study are assumptions for conventional brakes: what is e.g. the air flow at a pneumatic brake? It is highly dependent on usage (activations and pressure) and hence the evaluation is based on plausible use.

A lot of comparisons exist (by others and VE) showing the advantages of EMBs for passenger cars, but it is new to prove what exactly the VE-EMB can offer in detail with its special mechanism compared with air brakes. The conclusions are that firstly a spring engaged EMB with the smallest possible spring (by best using its energy with a cam) can be made in reality and secondly that the EMB offers even more advantages at CVs than at passenger cars.

Research and /or Engineering Questions/Objective:

The objective of this work is to derive CV, railway and elevator versions from the passenger car EMB and to show their technical data (actuator power and torque, actuation and ABS timing) and to compare it with typical data of pneumatic brakes. The elevator brake is present in hardware and goes to a test elevator, the railway version is mechanically designed on CAD for the “all electric metro project” and the CV version is calculated with the brake simulation.

Methodology:

The EMB simulation is always on top of development methodology. It uses realistic and calibrated values of elasticity of mechanical parts (caliper, pads, bearings, etc.) to calculate actuator torque, power, timing and actuation snail shape and auto-engage spring and cam. These values are used for CAD and the final drawing is used for CNC production.
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Results:
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Limitations of this study:
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What does the paper offer that is new in the field in comparison to other works of the author:
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Conclusion:
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