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Development of a Regenerative Braking System for Passenger Buses
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Regenerative braking system (RBS) is a kinetic energy storage system installed in parallel with conventional brakes in new generation of hybrid vehicles. These units result in higher overall efficiency and reduced emissions. However, there are no RBS systems in use for existing local buses of Sri Lanka. Also, available RBS systems in electric hybrid cars and similar vehicles cannot be directly fitted to the local passenger buses due to limited capacity and cost concerns. In this background, the aim of this research was to develop an alternative RBS applicable for passenger busses. After a detailed literature review and conceptual designs, a flywheel based RBS was selected mainly due to the installation, performance, maintenance and investment concerns. Accordingly, computer modelling and simulations were done to optimise the system configuration. Then, a physical model was fabricated consisting of an electric motor, variable speed drive and two flywheels. In order to simulate the regular operation of the bus, the motor was rotated at known speeds and a primary flywheel was attached to it through a fixed gearing. During the braking stage, the motor was disengaged from the primary flywheel and immediately after that, a secondary flywheel was engaged with it using a variable speed drive. During the generation cycle, the secondary flywheel was taken as the energy source for driving the primary flywheel through the variable speed drive. In both cases, the variable speed drive was set such that the flywheel which supplies energy always rotates at a higher speed compared to the flywheel which absorbs energy. Accordingly, the lab scale model resulted in 60% of braking energy regeneration, compared to 80% prediction by the simulations. With further developments, the proposed system has a higher potential to be used in real passenger busses as an effective RBS.

Keywords: passenger buses, flywheel based energy storage, regenerative braking, vehicle dynamics, braking energy recovery of automobiles