PROMISING DIRECTIONS FOR THE DEVELOPMENT OF ELECTROMECHANICAL CAR BODY TILTING TECHNOLOGIES IN HIGH-SPEED ELECTRIC TRAINS

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One of the key strategies for increasing the speed of railway transportation is the implementation of electric rolling stock equipped with car body tilting mechanisms [1]. This technology enables trains to travel through curves at higher speeds, offering a viable alternative to the costly investment in entirely new high-speed rail infrastructure. The effectiveness of tilting technology is demonstrated by the successful operation of over 65 train models developed by leading global manufacturers and deployed in 15 countries. These tilting systems use pneumatic, hydraulic, or electromechanical actuators, each with its own advantages and limitations. For instance, hydraulic systems include numerous high-pressure components, which can compromise system reliability and increase the risk of fluid leakage. Pneumatic systems, although structurally similar to hydraulic ones, exhibit slower response times due to the low density of air as the working medium. Nevertheless, pneumatic components are an essential part of modern train suspension systems and are widely applied in high-speed trains. Electromechanical systems, which are increasingly favored in modern designs, face challenges in emergency situations, as they typically lack the ability to automatically return the car body to its default position in the event of a power failure, raising safety concerns. While electromechanical drives based on linear motors offer self-return functionality, their considerable size and weight require additional space on the train bogies [2,3]. Developing an energy-efficient electric drive system optimized for weight, size, and energy parameters would enable the design of advanced running gear for high-speed electric trains. The selection of the type and design features of linear motors is primarily determined by the load characteristics, which, in turn, depend on the configuration of the bogie and the car body of the electric rolling stock. The motor's placement within the train structure also significantly influences its design. [2,3].

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