Analisis Variasi Desain Tunnel Portal pada Kereta Cepat Jakarta-Bandung terhadap Perubahan Tekanan dan Koefisien Drag pada Fenomena Micro-pressure Waves = Design Variations Analysis of Tunnel Portals on the Jakarta-Bandung High-Speed Train Regarding Pressure Changes and Drag Coefficient in Micro-pressure Wave Phenomena

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Abstrak

Peningkatan kebutuhan akan kemudahan transportasi antar wilayah, memacu pemerintah Indonesia untuk membuat insfrastruktur transportasi yang lebih baik. Untuk itu, dibuatlah proyek Kereta Cepat Jakarta-Bandung. Proyek ini menggunakan model kereta Fuxing CR400AF yang memiliki kecepatan operasional hingga 350 km/jam. Pada kecepatan tersebut, muncul masalah-masalah aerodinamik, salah satunya berupa micro-pressure waves. Fenomena tersebut menjadi masalah baru di berbagai negara, karena sangat berkaitan erat dengan peningkatan kecepatan kereta. Semakin tinggi kecepatan operasional kereta, akan meningkatkan nilai micro-pressure waves, yang dapat berdampak buruk bagi kesehatan manusia dan kekuatan konstruksi bangunan di sekitarnya. Pada penelitian ini dilakukan simulasi numerik, berupa CFD, menggunakan perangkat lunak ANSYS FLUENT. Skema pada penelitian adalah kereta melintasi sebuah terowongan, di mana fase awal micro-pressure waves terjadi saat kereta masuk terowongan. Fokus penelitian ini adalah pengukuran pressure gradient yang nilainya berkorelasi dengan micro-pressure waves. Terdapat 4 variasi tunnel portal, yaitu enlarged tunnel portal, enlarged vent tunnel portal, linear tunnel portal, dan tunnel portal walini, yang akan dibandingkan juga dengan terowongan tanpa tunnel portal. Hasil dari penelitian ini, desain tunnel portal walini memiliki maksimum pressure gradient yang paling rendah, dengan total penurunan 19,4% dibandingkan dengan variasi tanpa tunnel portal. Selain itu, juga diamati dampak perubahan variasi tunnel portal terhadap efek aerodinamik pada kereta. Hasilnya, perbedaan variasi antar tunnel portal tidak menunjukkan perbedaan yang signifikan, tetapi masih jauh menurun apabila dibandingkan dengan variasi tanpa tunnel portal. Variasi terbaik dapat menurunkan tekanan maksimum dan koefisien drag adalah enlarged tunnel vent portal, dengan masing-masing penurunan sebesar 19,7% dan 23,6%.
.....The increasing demand for interregional transportation convenience has driven the Indonesian government to establish improved transportation infrastructure, leading to the development of the Jakarta-Bandung High-Speed Train project. This project utilizes the Fuxing CR400AF train model, capable of operating speeds up to 350 km/h. At such velocities, aerodynamic issues arise, including the micro-pressure waves phenomenon. Micro-pressure waves have become a new concern in various countries as it is closely related to the increased speed of trains. The higher the operational speed of the train, the worse the impact of micro-pressure waves on human health and the structural integrity of surrounding buildings. In this study, numerical simulations (CFD) using ANSYS FLUENT software were conducted. The research scenario involved the train passing through a tunnel, where the initial phase of the micro-pressure waves occurred upon the train's entry into the tunnel. The primary focus of this study was to measure the pressure gradient, which correlates with the micro-pressure waves. Four variations of tunnel portals were considered: enlarged tunnel portal, enlarged vent tunnel portal, linear tunnel portal, and walini tunnel portal, all of which were

compared to a tunnel without a tunnel portal. The research findings indicate that the walini tunnel portal design exhibited the lowest maximum pressure gradient, with a total decrease of 19.4% compared to the variation without a tunnel portal. Additionally, the study examined the impact of different tunnel portal variations on the aerodynamic effects of the train. The results showed that the variations between tunnel portals did not significantly differ; however, they still exhibited considerable decreases compared to the variation without a tunnel portal. The enlarged vent tunnel portal was the best variation, capable of reducing maximum pressure and drag coefficient, with respective reductions of 19.7% and 23.6%.