

Pembangunan jalan bebas hambatan yang direncanakan hingga tahun 2040 mencapai panjang sekitar 17.851,99 km, sehingga meningkatkan kebutuhan perkerasan kaku berbahan beton. Beton dipilih karena keunggulannya dalam kekuatan, daya dukung, distribusi beban, umur layan panjang, serta ketahanan lingkungan. Namun, tingginya penggunaan beton menyebabkan konsumsi material konstruksi yang besar dan berpotensi menimbulkan masalah lingkungan. Untuk mengatasi hal tersebut, konsep konstruksi hijau (*green construction*) diterapkan dengan menggunakan material ramah lingkungan dan pemanfaatan limbah. Salah satu inovasi adalah penggunaan semen PCC (*Portland Composite Cement*) yang lebih ramah lingkungan dan pemanfaatan limbah *steel slag* sebagai agregat substitusi campuran beton. Pemanfaatan limbah ini tidak hanya mendukung kelestarian sumber daya alam, tetapi juga meningkatkan performa beton, baik dari segi kuat tekan, kuat tarik, maupun konduktivitas termal.

Penelitian ini bertujuan untuk mengkaji perilaku mekanika beton dengan menggunakan semen Portland Composite Cement (PCC) dan substitusi agregat *steel slag* sebagai bahan penyusun perkerasan kaku dengan kuat lentur rencana f_s 4,5 MPa. Variasi substitusi *steel slag* pada agregat kasar dan halus dilakukan dengan persentase 0%, 25%, 50%, 75%, dan 100%. Perancangan campuran beton (*mix design*) dilakukan dengan mengacu pada SNI 03-2834-2000. Penelitian dilakukan secara studi eksperimental di laboratorium, meliputi pengujian properti bahan, pembuatan benda uji, serta pengujian kuat tekan, kuat lentur, dan modulus elastisitas beton.

Penggunaan semen PCC dan substitusi agregat *steel slag* dapat meningkatkan performa mekanika beton. Berdasarkan hasil pengujian, kuat tekan beton pada spesimen M41-50% lebih tinggi dibanding spesimen M41-0%, yaitu sebesar 37,27 MPa. Hasil pengujian kuat lentur tertinggi terdapat pada beton *steel slag* dengan komposisi 100%, yaitu sebesar 5,11 MPa. Selain itu, modulus elastisitas aktual hasil pengujian beton dengan *steel slag* memiliki nilai yang lebih tinggi dibanding modulus elastisitas teoritis. Berdasarkan tinjauan mekanika beton, spesimen terbaik adalah spesimen M41-50%.

Kata kunci: Perkerasan Kaku, Semen PCC, *Steel Slag*, Perilaku Mekanika, *Green Construction*

The construction of toll roads planned until 2040 is projected to reach approximately 17,851.99 km, which directly increases the demand for rigid pavement made of concrete. Concrete is chosen due to its advantages in strength, load-bearing capacity, efficient load distribution, long service life, and environmental durability. However, the high usage of concrete results in significant consumption of construction materials, potentially causing environmental issues. To address this, the green construction concept is applied by utilizing environmentally friendly materials and waste recycling. One innovation is the use of Portland Composite Cement (PCC), which is more environmentally friendly, along with the utilization of steel slag waste as a substitute aggregate in concrete mixtures. This waste utilization not only supports the conservation of natural resources but also enhances concrete performance in terms of compressive strength, tensile strength, and thermal conductivity.

This research aims to study the mechanics behavior of concrete using Portland Composite Cement (PCC) and steel slag aggregate substitution as the building blocks of rigid pavement with a planned flexural strength of f_s 4.5 MPa. Variations of steel slag substitution in coarse and fine aggregates were carried out with percentages of 0%, 25%, 50%, 75%, and 100%. Concrete mix design was carried out with reference to SNI 03-2834-2000. Tests were carried out experimentally in the laboratory, including testing the properties of materials, making test specimens, and testing the compressive strength, flexural strength, and modulus of elasticity of concrete.

The use of PCC cement and steel slag aggregate substitution can improve the performance of concrete mechanics. Based on the test results, the compressive strength of concrete in the M41 50% specimen is higher than the M41-0% specimen, which is 37.27 MPa. The highest flexural strength test results were found in steel slag concrete with 100% composition, which amounted to 5.11 MPa. In addition to that, the actual modulus of elasticity of concrete test results with steel slag has a higher value than the theoretical modulus of elasticity. Based on the review of concrete mechanics, the best specimens are M41-50% specimens

Keywords: Rigid Pavement, PCC, Steel Slag, Mechanical Behavior, Green Construction