PENGARUH SUBSTITUSI PARSIAL SEMEN MENGGUNAKAN ABU SEKAM PADI (*RICE HUSK ASH*) DAN SEMEN MERAH LIMBAH BATU BATA PADA KUAT TEKAN MORTAR DENGAN TAMBAHAN ADMIXTURE SILICA FUME

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INTISARI

Produksi semen Portland berkontribusi signifikan terhadap emisi gas karbon dioksida (CO_2) global, sehingga diperlukan alternatif material konstruksi yang lebih berkelanjutan melalui pemanfaatan limbah sebagai bahan substitusi semen. Penelitian ini bertujuan untuk menganalisis pengaruh substitusi parsial semen menggunakan kombinasi abu sekam padi (Rice Husk Ash/RHA) dan semen merah limbah batu bata, serta penambahan admixture silica fume sebesar 5%, terhadap kuat tekan mortar pada berbagai umur pengujian, serta menentukan komposisi substitusi yang paling optimal.

Penelitian dilakukan secara eksperimental di laboratorium dengan menggunakan mortar semen–pasir pada perbandingan volume 1:4 dan faktor air-semen awal 0,6. Semen yang digunakan adalah semen PPC, sedangkan bahan substitusi berupa abu sekam padi dan serbuk limbah batu bata dengan variasi persentase tertentu terhadap berat semen. Seluruh campuran diberi tambahan silica fume sebesar 5%. Benda uji berupa kubus mortar 5×5×5 cm yang diuji kuat tekannya pada umur 7, 14, dan 28 hari sesuai standar SNI dan ASTM. Selain itu dilakukan pengujian pendukung berupa uji meja sebar, berat jenis mortar, dan daya serap air untuk menginterpretasi perilaku material.

Hasil penelitian menunjukkan bahwa substitusi parsial semen dengan kombinasi RHA dan limbah batu bata mempengaruhi perkembangan kuat tekan mortar secara signifikan. Pada umur 28 hari, kuat tekan tertinggi diperoleh pada kadar substitusi total 15% (kombinasi RHA dan limbah batu bata) dengan nilai 13,21 MPa. Nilai ini masih lebih rendah dibanding mortar kontrol yang mencapai 16,32 MPa, atau mengalami penurunan sekitar 19%. Meskipun demikian, baik mortar dengan substitusi 15% maupun mortar kontrol tetap termasuk dalam klasifikasi mortar tipe S menurut SNI 03-6882-2002. Penurunan kuat tekan relatif ini menunjukkan bahwa pada umur 28 hari, berkurangnya jumlah semen sebagai sumber utama reaksi hidrasi primer penghasil gel C-S-H serta penambahan faktor air semen dalam rangka kontrol syarat kelecakan (workability) mortar tidak sepenuhnya dapat dikompensasi oleh reaksi pozzolanik RHA dan efek filler serta densifikasi mikrostruktur akibat penambahan silica fume.

Secara umum, penelitian ini membuktikan bahwa pemanfaatan abu sekam padi dan limbah batu bata sebagai substitusi parsial semen, dengan dukungan silica fume, berpotensi menghasilkan mortar yang ramah lingkungan tanpa mengorbankan kinerja mekanisnya secara drastis. Temuan ini dapat menjadi dasar pengembangan material mortar berkelanjutan berbasis limbah lokal untuk aplikasi konstruksi.

Kata kunci: *mortar, abu sekam padi, limbah batu bata, silica fume, kuat tekan, material berkelanjutan*

THE EFFECT OF PARTIAL SUBSTITUTION OF CEMENT USING RICE HUSK ASH AND RED CEMENT OF WASTE BRICK POWDER ON THE COMPRESSIVE STRENGTH OF MORTAR WITH ADDITIONAL ADMIXTURE OF SILICA FUME

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ABSTRACT

Portland's cement production contributes significantly to global carbon dioxide (CO_2) emissions, so a more sustainable alternative to construction materials is needed through the use of waste as a cement substitute material. This study aims to analyse the effect of partial substitution of cement using a combination of rice husk ash (RHA) and red cement of brick waste, as well as the addition of 5% silica fume admixture, on the compressive strength of mortar at various test ages, and determine the most optimal substitution composition.

The research was conducted experimentally in the laboratory using cement-sand mortar at a volume ratio of 1:4 and an initial water-cement factor of 0.6. The cement used is PPC cement, while the substitution material is in the form of rice husk ash and brick waste powder with a certain percentage variation on the weight of cement. The entire mixture is given an additional silica fume of 5%. The test specimen is a 5×5×5 cm mortar cube which is tested for compressive strength at the age of 7, 14, and 28 days according to SNI and ASTM standards. In addition, supporting tests were carried out in the form of dispersion table tests, mortar specific gravity, and water absorption to interpret material behaviour.

The results showed that partial substitution of cement with a combination of RHA and brick waste significantly affected the development of the compressive strength of mortar. At 28 days of age, the highest compressive strength was obtained at a total substitution rate of 15% (combination of RHA and waste bricks) with a value of 13.21 MPa. This value is still lower than the control mortar which reached 16.32 MPa, or a decrease of around 19%. However, both mortar with 15% substitution and control mortar remain included in the classification of type S mortar according to SNI 03-6882-2002. This decrease in relative compressive strength suggests that at 28 days of age, the reduced amount of cement as the primary source of the primary hydration reaction of the C-S-H gel-producing as well as the addition of water-cement ratio (w/c) in order to fulfil the workability requirements of the mortar cannot be fully compensated by the RHA pozzolanic reaction and the filler effect and densification of the microstructure due to the addition of silica fume.

In general, this study proves that the use of rice husk ash and brick waste as a partial substitution of cement, with the support of silica fume, has the potential to produce an environmentally friendly mortar without drastically sacrificing its mechanical performance. These findings could form the basis for the development of local waste-based sustainable mortar materials for construction applications.

Keywords: *mortar, rice husk ash, brick waste, silica fume, compressive strength, sustainable material*