ABSTRAK

Struktur balok T beton bertulang merupakan elemen penting dalam bangunan, namun rentan mengalami kerusakan signifikan akibat gempa bumi, khususnya yang bersumber dari patahan dekat (*near-fault ground motion*) yang bersifat *pulse-like*, yaitu memiliki lonjakan percepatan dan kecepatan tinggi dalam durasi pendek. Penelitian ini bertujuan untuk mengevaluasi perilaku seismik balok T beton bertulang yang diperkuat dengan kombinasi *Ultra-High Performance Concrete* (UHPC) dan pelat *Carbon Fiber Reinforced Polymer* (CFRP) melalui pengujian eksperimental dan validasi numerik. Perkuatan menggunakan beton konvensional memiliki kelemahan seperti durabilitas rendah dan waktu konstruksi yang lama. UHPC sebagai material berperforma tinggi menawarkan kekuatan tekan tinggi, ketahanan terhadap retak, dan durabilitas unggul, sedangkan pelat CFRP memiliki kekuatan tarik sangat tinggi dengan bobot ringan. Kombinasi keduanya bertujuan untuk meningkatkan daktilitas, kapasitas beban, kekakuan, serta kemampuan disipasi energi balok secara signifikan. Penelitian dilakukan pada dua benda uji: SC (balok tanpa perkuatan) dan SP (balok dengan perkuatan UHPC dan CFRP). Pengujian menggunakan beban *pulse-like near-fault* yang dilanjutkan dengan pembebanan siklik konvensional. Hasil penelitian menunjukkan bahwa balok SP mengalami peningkatan kapasitas beban maksimum sebesar 40,6% pada momen negatif dan 65,98% pada momen positif dibandingkan balok SC. Kekakuan awal balok SP lebih tinggi dan degradasinya lebih lambat. Daktilitas balok SP meningkat sebesar 37,92%, dan kapasitas disipasi energinya jauh lebih besar dibandingkan balok kontrol. Validasi numerik dengan Response-2000 menghasilkan deviasi nilai beban maksimum sebesar 2–14% terhadap hasil eksperimen, menunjukkan bahwa model numerik dapat merepresentasikan respons lentur struktur dengan akurasi yang dapat diterima.

Kata kunci*: Perilaku seismik, Balok T beton bertulang, *Ultra High Performance Concrete (UHPC),* Pelat *Carbon Fiber Reinforced Polymer (CFRP), Near-fault ground motion.

ABSTRACT

Reinforced concrete T-beams are critical structural elements in buildings but are vulnerable to significant damage during earthquakes, especially those caused by near-fault ground motions characterized by pulse-like behavior, which involves high acceleration and velocity peaks over a short duration. This study aims to evaluate the seismic behavior of reinforced concrete T-beams strengthened with a combination of Ultra-High Performance Concrete (UHPC) and Carbon Fiber Reinforced Polymer (CFRP) plates through experimental testing and numerical validation. Conventional concrete strengthening methods often suffer from drawbacks such as low durability and extended construction time. UHPC, as a high-performance material, offers superior compressive strength, crack resistance, and durability, while CFRP plates provide exceptionally high tensile strength with lightweight properties. The combination of these materials is intended to significantly enhance the ductility, load-bearing capacity, stiffness, and energy dissipation capability of the beam. Two specimens were tested: SC (unstrengthened beam) and SP (beam strengthened with UHPC and CFRP). The specimens were subjected to a pulse-like near-fault loading followed by conventional cyclic loading. The results showed that the SP beam exhibited a 41% increase in negative moment capacity and a 65.98% increase in positive moment capacity compared to the SC beam. The initial stiffness of the SP beam was higher, with slower degradation. The ductility of the SP beam improved by 37.92%, and its energy dissipation capacity was significantly greater than that of the control beam. Numerical validation using Response-2000 showed a deviation in peak load values ranging from 2% to 14% compared to the experimental results, indicating that the numerical model can adequately represent the flexural response of the structure with acceptable accuracy.

Keywords*: S*eismic behavior, Reinforced concrete T-beam, Ultra-High Performance Concrete (UHPC), Carbon Fiber Reinforced Polymer (CFRP) plate, Near-fault ground motion.