



INTISARI

Penelitian berjudul “**Evaluasi Kapasitas dan Respons Nonlinear Elemen Baja Built-Up pada Prototipe Bangunan Modular**” dilatarbelakangi oleh kebutuhan elemen struktur modular yang memiliki kapasitas, kekakuan, kemampuan deformasi, dan kemudahan fabrikasi yang memadai. Permasalahan penelitian mencakup respons lentur balok *built-up rectangular hollow section* (RHS), kapasitas tekan kolom *built-up square hollow section* (SHS), kesesuaian pemodelan numerik terhadap eksperimen, serta pengaruh kondisi batas terhadap perilaku kolom. Penelitian ini bertujuan mengevaluasi kapasitas dan respons nonlinear kedua elemen melalui pendekatan eksperimental, teoretis, dan numerik.

Balok diuji menggunakan konfigurasi *four-point bending test* dengan pembebanan siklik satu arah berbasis kontrol perpindahan. Hasil pengujian dibandingkan dengan analisis teoretis, pemodelan makro, dan pemodelan mikro. Kolom dievaluasi menggunakan teori Euler, SNI 1729:2020, analisis makro, analisis tekuk linier mikro, dan analisis nonlinear *Static-Riks* pada kondisi *pinned-pinned* dan *fixed-fixed*. Analisis data meliputi kurva beban–perpindahan, *skeleton curve*, kekakuan awal, daktilitas perpindahan yang tercapai, momen ternormalisasi, kapasitas tekan, perpindahan lateral, distribusi tegangan, dan pola deformasi. Parameter material model mikro balok ditentukan melalui kalibrasi terhadap respons eksperimen karena pengujian tarik kupon tidak dilakukan.

Hasil penelitian menunjukkan bahwa rasio momen maksimum yang tercapai terhadap momen plastis teoretis sebesar 1,15. Rasio kapasitas momen model makro dan mikro terhadap eksperimen masing-masing sebesar 0,99 dan 1,02. Namun, rasio kekakuan awalnya sebesar 1,31 dan 1,04, sehingga model mikro lebih mendekati respons awal eksperimen, sedangkan model makro menghasilkan respons yang lebih kaku dan daktilitas lebih tinggi. Respons balok didominasi oleh lentur inelastis dengan tekuk lokal minor tanpa kegagalan las atau ketidakstabilan lateral yang dominan. Pada kolom, rasio kapasitas ultimit terhadap kapasitas aksial plastis berada pada rentang 0,80–0,90 untuk kondisi *pinned-pinned* dan 0,96–0,97 untuk kondisi *fixed-fixed*. Perubahan kondisi batas meningkatkan kapasitas tekan menjadi 1,08–1,19 kali dan menurunkan perpindahan lateral menjadi 0,19–0,31 kali kondisi *pinned-pinned*. Analisis makro efektif untuk mengevaluasi respons global, sedangkan analisis mikro memberikan informasi nonlinear dan lokal yang lebih rinci.

Kata kunci: *bangunan modular baja, baja built-up, balok RHS, kolom SHS, pemodelan numerik.*



ABSTRACT

The study entitled “Evaluation of the Capacity and Nonlinear Response of Built-Up Steel Members in a Modular Building Prototype” was motivated by the need for modular structural members with adequate capacity, stiffness, deformation capacity, and ease of fabrication. The research addressed the flexural response of a built-up rectangular hollow section (RHS) beam, the compressive capacity of built-up square hollow section (SHS) columns, the agreement between numerical modeling and experimental results, and the influence of boundary conditions on column behavior. This study aimed to evaluate the capacity and nonlinear response of both structural members using experimental, theoretical, and numerical approaches.

The beam was tested using a four-point bending configuration under unidirectional cyclic displacement-controlled loading. The experimental results were compared with theoretical analysis, macro-scale modeling, and micro-scale modeling. The columns were evaluated using Euler theory, SNI 1729:2020, macro-scale analysis, micro-scale linear buckling analysis, and nonlinear Static-Riks analysis under pinned-pinned and fixed-fixed boundary conditions. The evaluated parameters included load-displacement curves, skeleton curves, initial stiffness, achieved displacement ductility, normalized moment, compressive capacity, lateral displacement, stress distribution, and deformation patterns. The material parameters of the beam micro-scale model were calibrated against the experimental response because tensile coupon testing was not conducted.

The results showed that the ratio of the maximum achieved moment to the theoretical plastic moment was 1.15. The moment-capacity ratios of the macro- and micro-scale models to the experimental result were 0.99 and 1.02, respectively. However, their initial-stiffness ratios were 1.31 and 1.04, indicating that the micro-scale model more closely represented the initial experimental response, whereas the macro-scale model produced a stiffer response and higher displacement ductility. The beam response was dominated by inelastic flexural behavior, with minor local buckling and no dominant weld failure or lateral instability. For the columns, the ratios of ultimate compressive capacity to plastic axial capacity ranged from 0.80 to 0.90 under pinned-pinned conditions and from 0.96 to 0.97 under fixed-fixed conditions. Changing the boundary condition increased the compressive capacity to 1.08–1.19 times and reduced the lateral displacement to 0.19–0.31 times that of the pinned-pinned condition. Macro-scale analysis was effective for evaluating global response, whereas micro-scale analysis provided more detailed information on nonlinear and local behavior.

Keywords: modular steel building, built-up steel, RHS beam, SHS column, numerical modeling.