INTISARI

Gedung perkuliahan 8 lantai di Yogyakarta dibangun menggunakan struktur beton bertulang dengan sistem ganda, mengombinasikan sistem rangka pemikul momen khusus dan dinding geser sebagai elemen penahan beban lateral. Gedung ini mulai dibangun pada tahun 2017 dan dirancang berdasarkan SNI 1726:2012, SNI 2847:2013, serta Peta Sumber dan Bahaya Gempa Indonesia 2010. Dengan diterbitkannya SNI 1726:2019, SNI 2847:2019, dan Peta Sumber dan Bahaya Gempa Indonesia 2024, evaluasi kinerja seismik perlu dilakukan untuk meninjau kembali tingkat keamanan gedung berdasarkan ketentuan dan parameter kegempaan yang berlaku saat ini.

Penelitian ini mengevaluasi kinerja seismik gedung berdasarkan SNI 9273:2025 *Tier* 3 yang diadopsi dari ASCE 41-17 menggunakan analisis *pushover* pada perangkat lunak ETABS. Dalam analisis *pushover*, degradasi kekakuan elemen berlangsung otomatis seiring terbentuknya sendi plastis sehingga kondisi retak awal umumnya tidak perlu dimodelkan secara eksplisit sejak awal analisis. Namun, pendekatan *lumped plasticity* memiliki keterbatasan karena kurva *backbone* belum memerinci degradasi kekakuan pada fase transisi retak pra-leleh, yaitu saat momen telah melampaui kapasitas retak tetapi belum mencapai titik leleh pertama. Selain itu, beban gravitasi yang bekerja sebelum pembebanan lateral dapat menimbulkan retak awal sehingga kekakuan efektif elemen sesungguhnya telah menurun sejak awal analisis. Oleh karena itu, penelitian ini mengkaji dua variasi model sebagai pendekatan batas atas dan batas bawah, yaitu Model 1 (penampang utuh) yang mengasumsikan elemen belum mengalami retak awal dengan mutu material *expected strength* dan kualitas pengerjaan optimal, serta Model 2 (penampang retak) yang mempertimbangkan penurunan kekakuan akibat retak awal yang dipicu oleh beban gravitasi serta merepresentasikan pengaruh degradasi kekakuan pada fase transisi retak pra-leleh melalui reduksi kekakuan elemen.

Level kinerja struktur global kedua model berada di level *Immediate Occupancy* (IO) pada beban BSE-1E, sedangkan pada beban BSE-2E, kinerja struktur mengalami penurunan sehingga berada di rentang antara IO dan *Life Safety* (LS) baik arah X dan Y. Terkait *story drift*, Model 1 memenuhi syarat di kedua arah (X dan Y), sedangkan Model 2 tidak memenuhi pada arah Y. Pada evaluasi tingkat elemen, mayoritas ketidaksesuaian kriteria penerimaan baik *deformation-controlled action* dan *force-controlled action* terjadi pada elemen sekunder yang hanya memicu kerusakan lokal. Namun, terdapat ketidakpemenuhan pada elemen primer, yakni kolom tangga, yang penting sebagai jalur evakuasi vertikal darurat pasca-gempa. Kondisi kinerja seismik aktual struktur di lapangan berada di antara hasil kedua model bergantung pada kualitas pengerjaan dan mutu material di lapangan, di mana Model 1 merepresentasikan batas atas (*upper bound*) dan Model 2 merepresentasikan batas bawah (*lower bound*).

Kata Kunci: evaluasi seismik, nonlinier, *pushover*, sendi plastis, SNI 9273:2025

ABSTRACT

An 8-story reinforced concrete lecture building in Yogyakarta was constructed using a dual system combining a special moment-resisting frame and shear walls as lateral load-resisting elements. The building was built in 2017 and designed in accordance with SNI 1726:2012, SNI 2847:2013, and the 2010 Indonesian Seismic Hazard Map. Following the publication of SNI 1726:2019, SNI 2847:2019, and the 2024 Indonesian Seismic Hazard Map, a seismic performance evaluation is necessary to reassess the building's safety level based on current codes and seismic hazard parameters.

This study evaluates the seismic performance of a building in accordance with SNI 9273:2025 Tier 3, which is adopted from ASCE 41-17, using pushover analysis in ETABS. In pushover analysis, element stiffness degradation is automatically accounted for through the formation of plastic hinges; therefore, initial cracking conditions generally do not need to be explicitly modeled at the beginning of the analysis. However, the lumped plasticity approach has limitations because the backbone curve does not explicitly capture stiffness degradation during the pre-yield cracking transition phase, when the applied moment exceeds the cracking moment but has not yet reached the first yield point. In addition, gravity loads acting prior to lateral loading may induce initial cracking, causing the effective stiffness of structural elements to be reduced before the seismic analysis begins. Therefore, this study investigates two modeling approaches representing the upper-bound and lower-bound conditions. Model 1 (gross section) assumes that structural elements remain uncracked, with expected-strength material properties and optimal construction quality. Model 2 (cracked section) considers stiffness reduction due to initial cracking induced by gravity loads and represents the influence of stiffness degradation during the pre-yield cracking transition phase through the application of reduced effective stiffness.

The global structural performance level of both models falls within the Immediate Occupancy (IO) level under BSE-1E loading, whereas under BSE-2E loading, the structural performance decreases to a range between IO and Life Safety (LS) in both the X and Y directions. Regarding story drift, Model 1 satisfies the requirements in both directions (X and Y), while Model 2 does not comply in the Y direction. At the element-level evaluation, the majority of acceptance criteria non-conformances for both deformation-controlled and force-controlled actions occur in secondary elements, which only trigger local damage. However, a failure was identified in a primary element, namely the staircase column, which is important as a vertical emergency evacuation route in the post-earthquake condition. The actual seismic performance of the structure in the field lies between the results of the two models, depending on the construction quality and material properties, where Model 1 represents the upper-bound condition and Model 2 represents the lower-bound condition.

Keywords: seismic evaluation, nonlinear, pushover, plastic hinge, SNI 9273:2025