PENGARUH PENEMPATAN *TUNED LIQUID DAMPER* TERHADAP RESPON STRUKTUR PADA STRUKTUR GEDUNG BERTINGKAT TINGGI

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ABSTRAK

Pertumbuhan populasi yang pesat dan keterbatasan lahan di kawasan urban telah mendorong peningkatan kebutuhan akan hunian vertikal, seperti gedung apartemen. Namun, gedung bertingkat tinggi di wilayah seismik rentan terhadap beban dinamis gempa bumi, yang seringkali menimbulkan simpangan berlebih sehingga memengaruhi keamanan struktural dan kenyamanan penghuni. Salah satu solusi yang efektif dan hemat biaya untuk memitigasi respons gempa adalah penggunaan *Tuned Liquid Damper* (TLD), sebuah sistem peredam pasif yang memanfaatkan fenomena *sloshing* cairan dalam wadah untuk menyerap energi getaran. Penelitian ini bertujuan untuk menganalisis dan membandingkan secara komprehensif respons struktur dengan ragam penempatan TLD pada gedung apartemen 10 lantai di D.I. Yogyakarta. Metode analisis menggunakan pemodelan struktur beton bertulang aplikasi di SAP2000, dengan beban gempa disimulasikan melalui Analisis Riwayat Waktu *(Time History)* menggunakan rekaman gempa yang telah disesuaikan. TLD dirancang dengan *mass ratio* 2.5% dan diuji pada tiga variasi lokasi vertikal: Lantai 10 (atap), Lantai 7 (tengah), dan Lantai 4 (bawah). Parameter kritis yang ditinjau meliputi simpangan antar tingkat, *displacement* puncak, gaya geser dasar, dan percepatan *joint* teratas. Hasil analisis menunjukkan bahwa TLD efektif menurunkan respons struktur, dengan penempatan di Lantai 10 memberikan performa terbaik dan nilai parameter paling kecil, karena lokasinya berdekatan dengan titik simpangan maksimum sehingga memungkinkan penyerapan energi getar yang optimal. Sebaliknya, penempatan di Lantai 7 dan Lantai 4 terbukti kurang efektif dan justru menyebabkan simpangan antar tingkat melampaui batas simpangan yang diizinkan. Dengan demikian, penempatan TLD pada lantai atas sangat direkomendasikan untuk meningkatkan ketahanan struktur terhadap beban seismik.

Kata Kunci: Bak Air, Peredam Pasif, Struktur Gedung Bertingkat, *Tuned Liquid Damper* (TLD)

THE EFFECT OF TUNED LIQUID DAMPER PLACEMENT ON STRUCTURAL RESPONSE IN HIGH-RISE BUILDINGS

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ABSTRACT

The rapid growth of the population and limited land availability in urban areas have driven the increasing demand for vertical housing, such as apartment buildings. However, high-rise buildings situated in seismic regions are vulnerable to dynamic loads caused by earthquakes, often resulting in excessive displacement (drift) that compromises both structural safety and occupant comfort. An effective and cost-efficient solution for mitigating this seismic response is the application of the Tuned Liquid Damper (TLD), a passive control system that utilizes the fluid sloshing phenomenon within a container to absorb vibrational energy. This study aims to comprehensively analyze and compare the structural response under various TLD placement configurations within a 10-story apartment building located in D.I. Yogyakarta, a region classified under seismic design category D. The analysis methodology involved modeling the reinforced concrete structure (Special Moment Resisting Frame - SMRF) using SAP2000, with seismic loads simulated via time history analysis utilizing spectrally matched earthquake records. The TLD was designed with a Mass Ratio of 2.5% and tested across three vertical location variants: floor 10 (roof), floor 7 (middle), and floor 4 (middle). Critical parameters evaluated include inter-story drift, peak displacement, base shear, and peak joint acceleration. Results indicate that TLD effectively reduces the structural response, with placement on floor 10 yielding the best performance and the lowest parameter values across the board. This is primarily because its location near the maximum displacement point enables optimal absorption of vibrational energy. Conversely, placement on floor 7 and floor 4 proved significantly less effective, causing inter-story drift to exceed the allowable limit. Consequently, locating the TLD on the upper floors is strongly recommended to enhance the structural resilience against seismic demands.

***Keywords**: Water Tank, Passive Damper, High-Rise Structure, Tuned Liquid Damper (TLD)*