

## INTISARI

Pembangunan *Flyover* Aloha yang berada di Kabupaten Sidoarjo, Jawa Timur telah selesai pada tahap konstruksi, karena itu harus dilakukan uji kelayakan sesuai dengan Peraturan Menteri PUPR No. 41 tahun 2015 tentang Penyelenggaraan Keamanan Jembatan dan Terowongan Jalan. Salah satu uji kelayakan yang dilakukan, yaitu uji beban. Uji beban jembatan layang dilakukan dengan memberi beban truk untuk mengetahui respons perubahan posisi vertikal dan horizontal struktur jembatan layang menggunakan *Robotic Total Station* (RTS). Penelitian ini bertujuan untuk mendapatkan besar, arah, dan pola lendutan berdasarkan perubahan posisi titik pengamatan pada *flyover* struktur baja di segmen utara dan pada *flyover* struktur beton di segmen selatan saat diberi variasi beban truk. Penelitian ini juga bertujuan menentukan kelayakan struktur jembatan berdasarkan besaran lendutan vertikal yang terukur dengan *robotic total station* terhadap batas izin lendutan yang mengacu pada *American Association of State Highway and Transportation Officials Load and Resistance Factor Design Bridge Design Specifications*, edisi keenam tahun 2012.

Tahapan penelitian ini dimulai dengan persiapan data, yang meliputi penentuan koordinat titik kontrol menggunakan empat titik referensi (RTS dan *backsight*), verifikasi distribusi titik pantau, dan penetapan skema pembebanan. Pemantauan dilakukan menggunakan RTS di dua segmen *flyover* yaitu, segmen utara (struktur baja) dengan sembilan titik pantau dan segmen selatan (struktur beton) dengan lima titik pantau. Penelitian ini mencakup lima simulasi pembebanan bertahap, dimulai dari kondisi tanpa beban (0 truk), dilanjutkan dengan 2 truk, 4 truk, 6 truk, hingga mencapai beban maksimum dengan 8 truk yang memiliki total muatan 202,98 ton (rata-rata 25 ton per truk). Setelah pembebanan maksimum, pengurangan beban dilakukan secara bertahap hingga kembali ke kondisi tanpa beban (0 truk). Data hasil pengukuran dari 14 titik pantau, yang mencakup sudut horizontal, sudut vertikal, jarak, serta koordinat *easting*, *northing*, dan elevasi, diunduh dan diolah menggunakan perangkat lunak GeoMoS. Hasil pengukuran setiap simulasi dibandingkan dengan batas izin lendutan sesuai standar AASHTO LRFD *Bridge Design Specifications* edisi 2012, untuk mengevaluasi kelayakan struktur *flyover*. Analisis juga mencakup pola dan arah lendutan pada setiap titik pantau guna mengidentifikasi perilaku struktur terhadap variasi beban, baik di segmen utara maupun selatan.

Hasil penelitian menunjukkan bahwa besar lendutan vertikal terbesar di segmen utara mencapai -13,66 mm pada simulasi beban maksimum (8 truk), sedangkan di segmen selatan mencapai -13,8 mm. Setiap titik pantau dihitung untuk mendapatkan pola, arah, dan besar lendutan pada kondisi sebelum dan sesudah pembebanan. Analisis terhadap lendutan horizontal mengindikasikan pergeseran yang berbeda di setiap titik, dengan pola arah yang relatif konsisten pada beberapa titik, meskipun terdapat variasi akibat distribusi beban yang tidak seragam. Visualisasi pola lendutan juga memberikan gambaran mendetail terkait distribusi pergeseran di seluruh titik pantau, baik secara vertikal maupun horizontal. Semua hasil lendutan dibandingkan dengan batas izin lendutan yang ditentukan berdasarkan AASHTO LRFD *Bridge Design Specifications* edisi 2012, di mana batas maksimum lendutan untuk segmen utara adalah 90,0625 mm dan untuk segmen selatan adalah 44,0625 mm. Hasil lendutan yang diukur pada kedua segmen *flyover* berada di bawah batas izin, sehingga struktur dinyatakan layak dan stabil untuk menahan variasi beban.

Kata kunci: *robotic total station*, uji beban, lendutan vertikal dan horizontal, *Flyover* Aloha, batas izin lendutan

## ABSTRACT

The construction of the Aloha Flyover in Sidoarjo Regency, East Java, has been completed in the construction phase, therefore a feasibility test must be conducted according to the Ministry of Public Works and Housing Regulation No. 41 of 2015 concerning the Safety Management of Bridges and Tunnels. One of the feasibility tests carried out is the load test. The load test on the flyover is conducted by applying a truck load to determine the response of vertical and horizontal position changes in the flyover structure using a Robotic Total Station (RTS). This study aims to obtain the magnitude, direction, and pattern of deflection based on the changes in the observation point positions on the north segment of the steel structure flyover and the south segment of the concrete structure flyover when subjected to varying truck loads. This study also aims to determine the feasibility of the bridge structure based on the vertical deflection measured by the robotic total station against the allowable deflection limits in accordance with the American Association of State Highway and Transportation Officials Load and Resistance Factor Design Bridge Design Specifications, 6th edition, 2012.

The research stages begin with data preparation, which includes determining the control point coordinates using four reference points (RTS and backsight), verifying the distribution of monitoring points, and establishing the load scheme. Monitoring is conducted using RTS on two segments of the flyover: the northern segment (steel structure) with nine monitoring points and the southern segment (concrete structure) with five monitoring points. The study includes five staged loading simulations, starting from the no-load condition (0 trucks), followed by 2 trucks, 4 trucks, 6 trucks, up to the maximum load with 8 trucks having a total load of 202.98 tons (an average of 25 tons per truck). After the maximum load, the load is reduced gradually back to the no-load condition (0 trucks). The measurement data from 14 monitoring points, including horizontal angles, vertical angles, distances, as well as easting, northing, and elevation coordinates, are downloaded and processed using the GeoMoS software. The results of each simulation are compared with the allowable deflection limits according to the AASHTO LRFD Bridge Design Specifications 2012 edition to evaluate the feasibility of the flyover structure. The analysis also includes the deflection pattern and direction at each monitoring point to identify the structural behavior under varying loads, both in the northern and southern segments.

The results of the study show that the largest vertical deflection in the northern segment reached -13.66 mm during the maximum load simulation (8 trucks), while in the southern segment, it reached -13.8 mm. Each monitoring point is calculated to obtain the pattern, direction, and magnitude of deflection under pre- and post-loading conditions. The analysis of horizontal deflection indicates different shifts at each point, with relatively consistent directional patterns at several points, although variations occurred due to uneven load distribution. Visualizing the deflection pattern also provides detailed insights into the distribution of shifts across all monitoring points, both vertically and horizontally. All deflection results are compared with the allowable deflection limits set by the AASHTO LRFD Bridge Design Specifications 2012 edition, where the maximum allowable deflection for the northern segment is 90.0625 mm and for the southern segment is 44.0625 mm. The measured deflection results on both segments of the flyover are below the allowable limits, thus the structure is declared feasible and stable to withstand varying loads.

Keywords: robotic total station, load test, vertical and horizontal deflection, Aloha Flyover, allowable deflection limits