Studi Permodelan & Eksperimental Karakteristik Dinamik pada Struktur Jembatan Slab-on-Pile = Modelling and Experimental Study of the Dynamic Characteristics of a Slab-on-Pile Bridge Structure

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Abstrak

Dalam 5-6 tahun terakhir, pembangunan infrastruktur di Indonesia dipercepat. Banyak masalah terkait pengadaan lahan yang terjadi, karena itu digunakan struktur jembatan slab-on-pile sebagai solusi. Akibat properti unik struktur slab-on-pile dimana batasan antara struktur atas dan bawahnya yang sangat ambigu, dan fakta bahwa struktur slab-on-pile banyak digunakan pada proyek jalan tol elevated sedangkan menurut KKJTJ, setiap jembatan elevated yang panjangnya melebihi 3 km perlu dilakukan uji dinamik, maka dari itu, perlu dilakukan pengujian dinamik lateral terhadap struktur slab-on-pile agar bisa dianalisis karakteristik dinamiknya. Pada penelitian ini, pengujian dinamik lateral menggunakan eccentric mass shaker dilakukan terhadap struktur jembatan slab-on-pile agar diketahui frekuensi alaminya. Data yang diolah menggunakan proses FFT (fast fourier transform) dan FDD (frequency domain decomposition) divalidasi terhadap beberapa model struktur yang divariasikan dalam permodelan pondasinya serta jenis elemen yang digunakan. Terdapat 3 variasi jenis permodelan pondasi yaitu Full (dimodelkan seutuhnya), Fix.Point (dijepit pada taraf penjepitan lateral) dan Ground (dijepit pada elevasi ground) dan 2 variasi jenis elemen yang digunakan yaitu Frame & Shell dan Elemen Solid. Model dibuat menggunakan program Midas Civil. Didapatkan nilai frekuensi alami struktur sebesar 3.3 Hz dalam arah longitudinal dan 4.5 Hz dalam arah transversal. Frekuensi alami dari pengujian setara dengan model dalam arah longitudinal, namun jauh lebih besar dari model dalam arah transversal. Hal ini karena dalam proses pemancangan spun pile, terjadi pemadatan tanah di sekelilingnya sehingga dalam arah transversal, dimana jarak antar pile kecil, kekakuan tanah meningkat. Dari penelitian ini juga didapat kesimpulan bahwa model yang paling akurat untuk memodelkan struktur slab-on-pile adalah model struktur yang dijepit pada taraf penjepitan lateral yang menggunakan elemen frame dan shell (FS- FIX.POINT) untuk arah longitudinal dan model struktur yang dijepit pada elevasi ground yang menggunakan elemen frame dan shell (FS-GROUND) untuk arah transversal.

.....In the last 5-6 years, infrastructure development in Indonesia has accelerated greatly. This causes land availability issues, which are solved by implementing slab-on-pile structures for bridge construction. Due to slab-on-pile bridges not having a clear border between their superstructure and substructure, and the fact that slab-on-pile bridges are often used for elevated toll road projects where KKJTJ states that all elevated toll roads spanning over 3 km must be assessed for its dynamic capabilities, a lateral dynamic test becomes relevant to conduct in order to analyze the structure’s dynamic characteristics.. In this research, a slab-on-pile bridge structure is tested for its lateral dynamic capacities using an eccentric mass shaker so that its natural frequencies can be obtained. The data processed using the FFT (fast fourier transform) and FDD (frequency domain decomposition) methods are compared with the values obtained from numerical models made using Midas Civil. Several models were made with variations on the spun pile foundation modelling method and the elements that were used for the model. Three spun pile foundation modelling method variations were used: Full (foundation fully modelled), Partial (foundation fixed at its fixity point), and

Ground (foundation fixed at ground level); two variations of elements were used: Frame & Shell and Solid Element. The tests result in a longitudinal natural frequency of 3.3 Hz and a transversal natural frequency of 4.5 Hz. The longitudinal natural frequency is similar with the model's longitudinal natural frequency. However, the transversal natural frequency is 16.9 – 32.8% higher than the model's transversal natural frequency. This is caused by the erection of the spun pile foundation that causes its surrounding soil in the transversal direction to condense, which in the case of very short pile spacing distances, causes the soil stiffness to increase. The tests and models also show that the most accurate model in the longitudinal direction is the FS-FIX.POINT model which were given fixed restraints at its fixity point and is modelled using the frame & shell elements. In the transversal direction, the most accurate model is the FS-GROUND model which were given fixed restraints at ground level and is modelled using frame & shell elements.