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**Evaluasi Respon Dinamis dan Modifikasi Baseplate Crude Oil Transfer Pump Menggunakan Metode Harmonic
Response Finite Element Method**
Muhammad Faada Daffa Pradana, Ir. Irfan Bahiuddin, S.T., M.Phil., Ph. D. IPM., ASEAN.Eng
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ABSTRACT

PT Pertamina Hulu Energi West Madura Offshore (PHE WMO) operates the Crude Oil Transfer Pump P-603 C at the Poleng Processing Platform facility. Condition monitoring data collected in December 2024 recorded the highest overall vibration velocity of 5.874 mm/s RMS at the Motor Outboard Horizontal (M1H) point, classified as unsatisfactory (Zone C) according to ISO 10816-3. Bump test results indicated that the natural frequency of the baseplate structure (26.50 Hz) lies very close to the motor's operating excitation frequency (24.42-24.50 Hz). This produces a separation margin of only 8.2-8.5%, well below the industry safety threshold of 15-20%. Consequently, the structure is prone to resonance. This study aims to evaluate the dynamic characteristics of the existing baseplate and to design a structural modification using the Finite Element Method (FEM) through modal and harmonic response analysis. The numerical model was built with a 35 mm element size (34,056 nodes and 5,100 elements), determined through a mesh independence study, and validated against bump test data. Three modification alternatives were evaluated in stages to increase lateral stiffness and reduce the baseplate's unsupported span. The results show that Alternative I did not meet the separation margin target (10,0%), although its amplitude reduction met the target (37.8%). In contrast, Alternatives II and III satisfied both success criteria. Alternative III, which adds two additional support legs at the mid-span, showed the best performance, with a separation margin of 33.8% and a vibration amplitude reduction of 94.2% relative to the existing condition. Furthermore, Alternative III did not exceed the yield strength of the ASTM A36 material. Based on these technical criteria, Alternative III is recommended as the optimal baseplate modification design to resolve the resonance issue on unit P-603 C.

Keywords: baseplate, resonance, harmonic response, finite element method, vibration, crude oil transfer pump

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INTISARI

PT Pertamina Hulu Energi West Madura Offshore (PHE WMO) mengoperasikan *Crude Oil Transfer Pump* P-603 C pada fasilitas *Poleng Processing Platform*. Hasil pemantauan *condition monitoring* bulan Desember 2024 menunjukkan nilai *overall vibration* tertinggi sebesar 5,874 mm/s RMS pada titik Motor Outboard Horizontal (M1H), yang berdasarkan ISO 10816-3 termasuk kategori *unsatisfactory* (Zona C). Hasil *bump test* menunjukkan frekuensi alami struktur *baseplate* (26,50 Hz) berada sangat dekat dengan frekuensi eksitasi operasi motor (24,42-24,50 Hz). Kondisi ini menghasilkan *separation margin* hanya 8,2-8,5, jauh di bawah batas aman industri (15-20%). Dengan demikian, struktur berpotensi mengalami resonansi. Penelitian ini bertujuan mengevaluasi karakteristik dinamis *baseplate* eksisting serta merancang modifikasi struktur menggunakan metode *Finite Element Method* (FEM) melalui analisis modal dan *harmonic response*. Model numerik dibangun dengan ukuran elemen 35 mm (34.056 *node* dan 5.100 elemen) hasil *mesh independence study*, kemudian divalidasi terhadap data *bump test*. Tiga alternatif modifikasi struktur dievaluasi secara berjenjang untuk meningkatkan kekakuan lateral dan mengurangi bentang bebas *baseplate*. Hasil menunjukkan bahwa Alternatif I belum memenuhi target *separation margin* (10,0%), meskipun penurunan amplitudonya telah memenuhi target (37,8%). Sebaliknya, Alternatif II dan Alternatif III memenuhi kedua kriteria keberhasilan. Alternatif III, dengan penambahan dua kaki tumpuan tambahan di tengah bentang, menunjukkan performa terbaik, yaitu *separation margin* 33,8% dan penurunan amplitudo getaran sebesar 94,2% terhadap kondisi eksisting. Selain itu, Alternatif III tidak menimbulkan risiko kegagalan tegangan terhadap *yield strength* material ASTM A36. Berdasarkan kriteria teknis tersebut, Alternatif III direkomendasikan sebagai desain modifikasi struktur *baseplate* yang paling optimal untuk mengatasi permasalahan resonansi pada unit P-603 C.

Kata kunci: *baseplate*, resonansi, *harmonic response*, *finite element method*, getaran, *crude oil transfer pump*