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Perturbed Partial Cavity Drag Reduction at High Reynolds Numbers SIMO MAKIHARJU, University of Michigan, BRIAN ELBING, ANDREW WIGGINS, DAVID DOWLING, MARC PERLIN, STEVEN CECCIO, University of Michigan — Ventilated partial cavities were investigated at Reynolds numbers to 80 million. These cavities could be suitable for friction drag reduction on ocean going vessels and thereby lead to environmental and economical benefits. The test model was a 3.05 m wide by 12.9 m long flat plate, with a 0.18 m backward-facing step and a cavity-terminating beach, which had an adjustable slope, tilt and height. The step and beach trapped a ventilated partial cavity over the longitudinal mid-section of the model. Large-scale flow perturbations, mimicking the effect of ambient ocean waves were investigated. For the conditions tested a cavity could be maintained under perturbed flow conditions when the gas flux supplied was greater than the minimum required to maintain a cavity under steady conditions, with larger perturbations requiring more excess gas flux to maintain the cavity. High-speed video was used to observe the unsteady three dimensional cavity closure, the overall cavity shape, and the cavity oscillations. Cavities with friction drag reduction exceeding 95% were attained at optimal conditions. A simplified energy cost-benefit analysis of partial cavity drag reduction was also performed. The results suggest that PCDR could potentially lead to energy savings.

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