ABSTRACT

This final research investigates the conceptual engineering design of a primary ring dike flood defense system for the 2,300-hectare IJstad land reclamation project in the shallow IJmeer basin. The study addresses flood risks from variable water levels, severe storm winds, and wave run-up, compounded by highly compressible Holocene subsoil consisting of soft clay and peat. The objective is to evaluate whether an optimized nature-based dike profile can satisfy strict statutory safety standards under extreme meteorological loading.

Utilizing localized meteorological, bathymetric, and DINOloket geotechnical data, the structural evaluation adopts a 1:30,000 annual failure probability standard. Based on a design wind speed of 30 m/s and an effective fetch of 5,569.197 m, calculations yield a wind setup of 12.8 cm, an unattenuated wave height (*Hm0*) of 1.35 m, and a peak wave period Ts) of 4.03 s, establishing a Design Water Level (DWL) of 2.528 m NAP. Under a zero-overtopping framework, this profile restricts the mean discharge (q) to 0.52 l/s per meter, well below the 1.0 l/s statutory limit.

The selected design features a total base length of 151.5 m, a 3.0 m crest width, a 1:3 inner slope, and an ultra-gentle 1:10 outer slope integrated with a 50-meter-wide berm, locking the final crest level at +3.55 m NAP. This broad geometry effectively minimizes shear stresses on the weak foundation. Under-seepage is managed via a 151.15 m horizontal path. Evaluated by Sellmeijer's Rule for the 0.6 m sand aquifer (d70) = 0.00015 m), the critical hydraulic head of 55.87 m vastly exceeds the active head of 3.73 m, achieving a piping Factor of Safety (FoS) of 15. Additionally, limit equilibrium analysis confirms outer slope stability at an exceptionally safe Factor of Safety (FS) of 10.1.

The results demonstrate that the nature-based dike system is structurally feasible for flood defense and geotechnical stability. Future development requires advanced numerical simulations via PLAXIS or GeoStudio to validate long-term soil consolidation and three-dimensional hydraulic behavior before implementation.

Keywords: ring dike, wave overtopping, Sellmeijer's Rule, slope stability, nature-based dike, IJSTAD