TWO-PHASE FLOW MODELING OF CLEAR-WATER ONSET AND JET SCOUR UNDER OFFSHORE PIPELINES

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A two-phase flow model is presented for simulating early stages of local scour due to steady current under offshore pipelines. Fluid phase is computed with solving Reynolds Averaged Navier-Stokes (RANS) equations in conjunction with a standard k-ε turbulence model for turbulence closure. Governing equations on fluid phase are solved using Finite Volume Method in a Cartesian coordinate system. On the other hand, seabed under pipeline is treated as an assembly of discrete sand grains, in which local scour is introduced as motion of granular media under the action of unsteady flow from the Lagrangian point of view; while simulation is done by calculating contact forces and displacements of individual grains under the flow action. Motion of every sand particle is traced with a numerical code based on Distinct Element Method (DEM), in which the frequent interparticle collision is described with spring and dashpot system, as shown in Fig.1.

First, flow model is developed by solving the RANS equations with k-ε turbulence model. Results are then employed in one-way calculation approach to anticipate sediment phase, estimate fluid-induced soil response and investigate hydrodynamics of seabed grain motion. Then, link between fluid and seabed models is established to incorporate all in one by introducing two-phase coupling system. Laboratory measurements (Mao, 1986) have been conducted to calibrate and verify model parameters.

Based on numerical results obtained in this study, it is concluded that numerical experiments evident that interparticle collisions of moving sand grains induce a predominant micro-mechanism on different stages of local scour around offshore pipelines and therefore it is concluded that two-phase modeling provides an accurate simulation on fluid phase and sediment transport occurring in local scour under offshore pipelines.
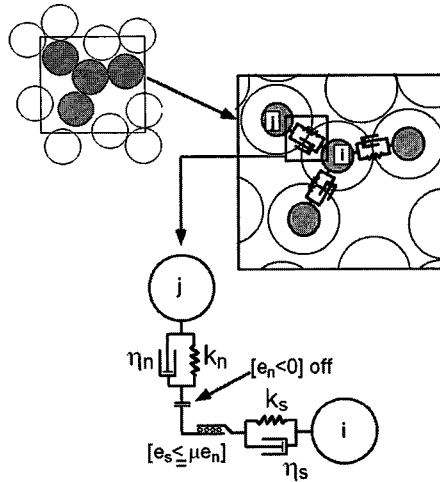
Fig. 1 Multiparticle collision and interaction system between contacting
grains in two-phase model, Gotoh and Sakai (1997)

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