EXPERIMENTAL INVESTIGATION OF OIL SPILL CONTAINMENT BY GRANULES CONTAINED BEHIND A RIGID BARRIER

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To study the efficiency of oil spill containment booms, small-scale experiments have been done using LECA® granules as substitute material for oil. The behaviour of granules trapped by a rigid barrier has been investigated doing systematic experiments in a laboratory flume. The effects of barrier depth and mean flow velocity have been studied for oil slicks with two different volumes.

Experiments are undertaken in a 0.5 m wide, 13.85 m long and 0.8 m deep flume. For all experiments the water depth is fixed at 0.6 m. A rigid barrier is located in the middle of the flume. After establishing a mean flow velocity a certain volume of granules is poured on the water surface upstream of the barrier.

Experimental results show that the behaviour of contained granules varies for different flow and barrier conditions. Three different modes of containment were observed.

For the first containment mode, the barrier draft is deeper than the depth of the accumulated granulates. Hence, the percentage of granule leakage is very low (less than 10 %). Granules are separated from the upstream part of the initial layer and are displaced by the flow to form a local thickening of the layer. The layer thickness in the vicinity of the barrier is almost not affected by this displacement process. Hence, this results in a low rate of granule leakage passed the barrier.

For the second containment mode, the accumulated granule reaches the barrier after a while. This causes partial failure of the containment process. During failure a continuous leakage of granulates occurs. The amount of material transferred to the downstream of the barrier is between 10 and 50 %.

For the third containment mode the barrier is not able to contain the granules. The major part of granules is lost in a few minutes. This mode occurs in flows with high velocity. The percentage of escaped material is more than 50 %.

Analysis of experimental results indicates the Froude number as an effective parameter in containing condition. The percentage of escaped material was considered as a representative parameter of containment failure. At high Froude numbers the containment is less successful (Fig. 1).

It was illustrated that increasing the material volume can influence the containment mode and increase the percentage of lost material. The rate of loss for second and third modes of containment is compared. The second mode starts with a low rate of containment and after a gross loss the rate of containment becomes low again. In the third mode of containment the loss rate is high in the beginning but it decreases rapidly (Fig. 2).

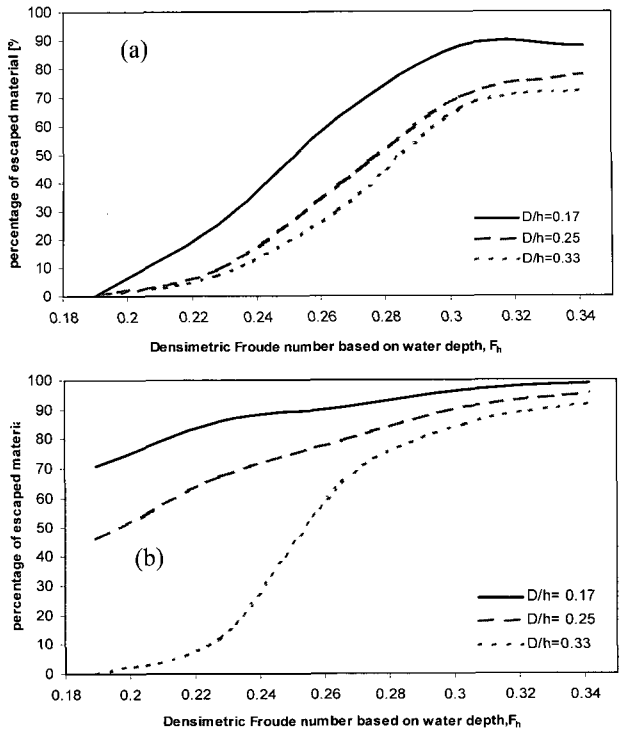

Fig. 1 Percentage of loss as a function of densimetric Froude number F_h for barriers with different draft to water depth ratio: a) for an initial non-dimensional slick volume of 0.055; b) for an initial non-dimensional slick volume of 0.111.

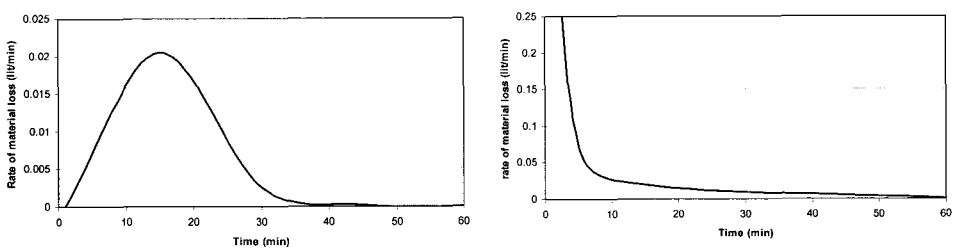

Fig. 2 Rate of material loss: a) second mode of containment; b) third mode of containment