**Title**

Photogrammetric Deformation Analysis of a Quay Wall: Stochastic non-linear least-squares deformation analysis from photogrammetric measurements on a quay wall

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**Abstract**

In recent years, unstable quay walls are a problem in The Netherlands. 100-year-old quay walls in cities like Amsterdam are collapsing and endanger people and property. The government needs to renovate unstable quay walls quickly. With 600 kilometre of quay wall in Amsterdam alone, this is a great challenge. Currently, unstable walls are found by deformation monitoring using tacheometry, which takes too much time for large scale monitoring. To increase both speed and coverage, a photogrammetric deformation analysis is proposed. In multiple epochs, at months interval, a series of images of the quay wall is made from a boat. In these images, feature points are identified and matched, where part of the feature points are matched across multiple epochs. All feature point observations are put in a multi-epoch least squares adjustment. This adjustment integrates both feature point observations of individual epochs and point deformations between multiple epochs. Using photogrammetry in combination with such a deformation adjustment has not been done previously, but has great advantages. The least squares adjustment allows to take the stochastic nature of the observations into account. This enables proper error propagation, such that not only quay wall stability can be assessed, but also the corresponding error budget. Results show that using two epochs 300 multi-epoch feature points can be found per square meter quay wall. With these points, sub-centimetre deformation can be estimated.