Summary

Spillage and accidental releases in dry bulk materials handling industry not only produce the materials losses, but also are the source of potential hazardous substances to the environment. As more and more government, corporations and individuals paying more attention to environmental problems, they believe that minimizing or avoiding the pollutants from the beginning is more effective than treating them after they have been created. Although compared to continuous dry bulk materials handling systems, applying a grab crane leads to possible material losses. However their extraordinary versatility and low cost still make them the most commonly used tools in their field. This makes the attempts to minimizing or avoiding the spillage when using grabs more meaningful.

There are several effective ways to collect the spillage materials during grab working, but there is no such a way to quantify the amount and distribution of spillage, except some rough methods. Quantifying the amount and distribution of spillage by simulation method before the operations is a good mean to help the bulk terminal planner make some quick and effective decisions.

Grab bucket is always mounted on cranes or derricks, which make the movement of bucket in space is hard to control and manage. In this study, according to robotic technologies, a four degrees of freedom crane model are built to model the crane and then to calculate the position of bucket. The involvements of human factors and the flowability of bulk materials decide the bulk material handling process as full of randomness. In the model, the spilling of bulk materials is a random process. It can be divided into two: continuous and discrete process. Each process has its own properties related to several factors and is modelled with some distributions to describe its characteristics and to make the simulation results more accurate and robust. After the spilling, the horizontal plane is divided into a group of grids to contain the spillage which could be used to calculate how large the affected area is. This model is versatile; a lot of factors could be changed by the user, such as carrier dimension, crane dimension, hopper dimension and location, terminal layout configuration and etc.

Unloading bulk materials from carriers is not just about choosing a crane with a grab bucket and then let it work. Although the total material loss doesn't cost too much depending on the mateiral, if thinking about it in an environmental and long term view, the work done in this study worth a lot. Before the unloading operation, the good crane erection planning could minimize the materials losses amount. And if possible, the position of the receiving hopper could also be relocated to realize this purpose. If two operation plans have a nearly same spillage amount, an operation having more concentrated spillage distribution could be suggested by the model. During the unloading operation, the velocity synchronization sequence of each joint of the crane could also minimize the spillage amount in an economic way. By the suggestions from the model, the spillage materials collection sheet could be put to an appropriate position where the potential spillage could fall on. After the unloading operation, according to the simulation results, the spillage collection equipment could be sent to the area which has the spillage material at the very first time.