Wind Fence Effectiveness – Case Study, Vale.

Situation

Vale S.A. is the world's largest producer of iron ore pellets. Their main plant is at Vitoria, a coastal city in Brazil. The Vitoria plant covers approximately 5 square kilometers and is 5 km upwind across an open bay from a major housing area.

There are several yards with stockpiles of pellets, coal and other materials up to 14m high and over 1km long.

Dust Control Investigation.

To control the dust from the plant, in 2008 Vale initiated a comprehensive wind fence program.

The preliminary stage was to engage the Midwest Research Institute to analyse their yards using CFD (Computational Fluid Dynamics) based on aerodynamic porosity and design information provided by

WeatherSolve. From that report, the MRI predicted a dust control level (in this case control of TSP which is the finest dust suspended in the air) of 80%.

They also engaged a consultant to monitor the dust for 45 days at heights of 4,8,12, 16 and 20m above the ground around the perimeter of one of the yards that was close to the sea. The sampling was done on an hour by hour basis with wet days removed from the sample set.

With the dust base level established, a wind fence was then built.

The wind fence was built using Brazilian structural engineers in tandem with WeatherSolve structural and environmental engineers to create a reliable system that matched the aerodynamic modelling of the MRI. The yard chosen for the sampling test is approximately 400m x 300m, with piles around 14m high.

The fence height is about 18m

Photo August 2009. Note one of the monitoring towers towards the back of the photo.

Some ground contouring was done. In other places the fence followed the contour as shown below.

After the fence was installed, the monitoring program was run for another 45 days. (They waited for a time when similar weather and yard activities to the pre-fence monitoring program were occurring.)

The results showed an effectiveness of 77.4% in the control of TSP (Total suspended particulate) leaving the yard.

A video referencing this work can be found on the Vale website through:

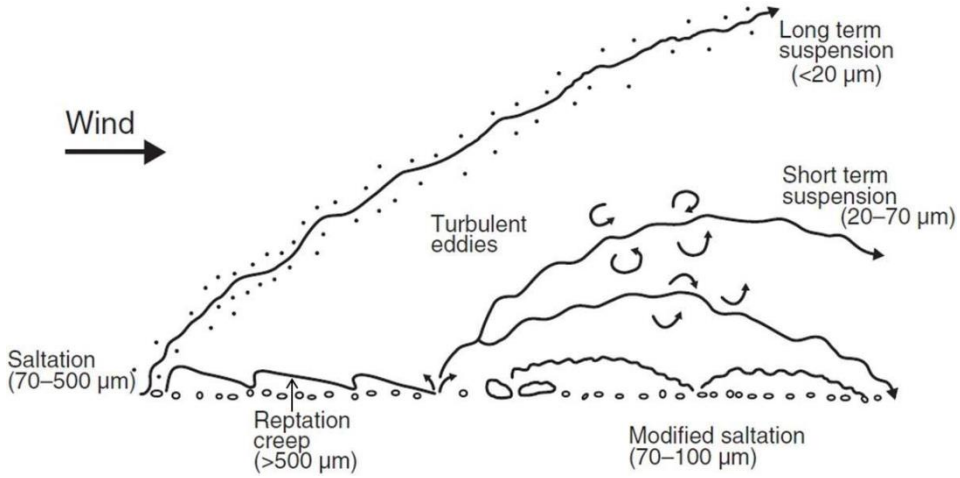
http://www.youtube.com/watch?v=LCE_loyN2Fs

Since 2009, Vale has worked with WeatherSolve in building approximately 14km of wind fence in Vale operations in Vitoria, Oman and Canada, and another 3km of fence in a project jointly owned with BHP. The tallest of those fences are 28m high to reach the target levels of control set by Vale.

Nearly all of those fences have been done in conjunction with CFD analysis from the MRI.

Note on total control levels

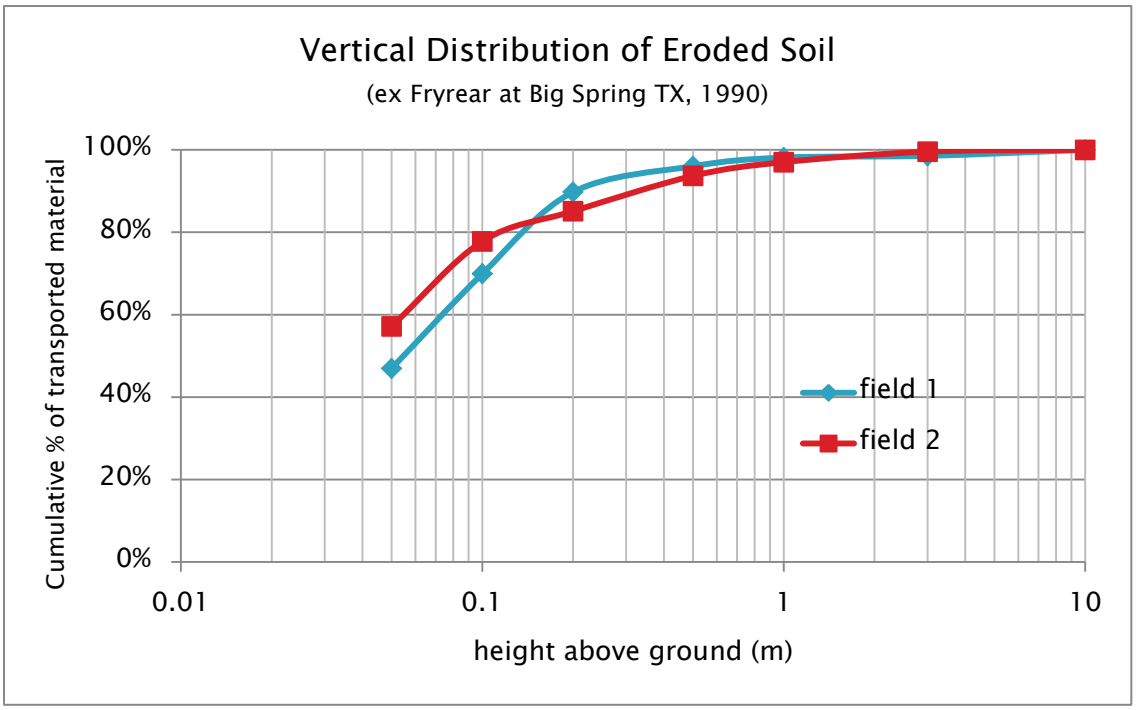
Actual control is higher than 77.4% as the fence also controls the considerable volume of larger dust particles that erode off the pile and roll or skip (saltate) onto the roadways before being crushed and dispersed further. Erosion research in Texas has shown that typically the volume of saltating particles is several times greater than the TSP volume.



The diagram above shows the different transport modes of dust particles. TSP measures the long and short term suspension volumes – i.e. particles smaller than about 70 microns. Larger particles very rarely get higher than 0.3m above the surface of the stockpile or ground apart from during their fall from a conveyor or stacker/reclaimer.

The graph below shows measured volumes of dust in two storm events over bare fields. It shows that at least 85% of the dust never gets higher than 0.3m above the ground. These are the larger particles that are not considered in the TSP calculations, but which become TSP if they get crushed on a roadway

outside the perimeter of the stockpile. Wind fences with a base wall or steep perimeter embankment control this dust too – and usually to the 100% level.



The total dust control may then be considered as follows:

$$77.4\% \times (1 - 0.85) + 100\% \times 0.85 = 96.6\%$$

where the first part of the equation is the control of the TSP fraction (0.15) and the second part is the control of the saltating fraction (0.85) for an overall control of 96%.