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A typical daily scene from a landfill site.

Machine control system and installation requirements

How to achieve best practice landfill management

My first article gave an overview of landfill design and the benefits of using machine control as part of normal landfill operating practices. This article continues the theme and will present an overview of the machine control functionality and operation and the components and installation necessary to achieve them.

Landfill Machine Control—Functionality and Operation

To reap the benefits listed in my previous article the Landfill Machine Control System needs the following functionality:

1. Monitor approach to the target density required for the landfill site and record the progress of work done to achieve this aim. The operator is notified when this is achieved so that unnecessary passes are avoided and the machine works as efficiently as possible. This requires the monitoring of the machine position, attitude and direction of travel relative to the waste placement within a digital terrain model (DTM). The DTM is the site design and defines the shape, structure and cell layout of the site. It will include avoidance areas which the machine control system can monitor for and warn the operator if he approaches / enters such a restricted area.
2. Update the design as it progresses in real time. Every time the compactor travels over waste the site topography is being changed and this data is essential in determining compaction and work to design targets.
3. Relay this data to the operator in a variety of formats ensuring compatibility with standard compaction

techniques e.g. monitoring pass counts and lifts.

4. Give the operator the ability to enter design changes within the DTM such as slopes necessary for good leachate management.
5. Record all the data giving a real time document of the site design as it updates and grows and transmit this information to the office which in turn can remotely update the design data and target objectives of the machine control system(s), also known as command and control.
6. Be able to work with multiple machines onsite such that all machines data can be shared giving a co-ordinated development of the site.

A whole host of additional functions will be available to the user, but the above list covers the key points required to achieve the main aim of optimum compaction and build to design.

Landfill Machine Control—System Components

A typical installation comprises of three major component areas :

1. Machine components
2. Repeater Station
3. Office Hardware and Software

Machine Installation

Firstly, let's look at the machine—the Landfill Compactor. This is a purpose built machine specifically designed for the compaction of waste and as can be seen it is a heavy duty piece of kit. Its wide footprint, wheel design and heavy build ensure optimum compaction for the machine size, with the front blade giving the ability for the movement of site waste in a similar manner to that of a dozer. Note, that it is also common for dozers to be used on the landfill site and whilst they contribute towards waste compaction their task is normally in the movement of the deposited waste and cover operations, it is the compactor that is used to realise optimum density.

A standard type landfill compactor.

A typical Landfill Compactor

Because of the limited number of moving components the complexity of monitoring is somewhat reduced from that of say a 3D machine control solution for an excavator.

The critical measurements needed to give 3D machine control monitoring for this application are :

1. Position
2. Machine pitch / roll
3. Machine direction (forward / reverse)

Position is achieved using a single RTK GPS / GNSS solution. This will require correction signals for the RTK network and so a GPS modem (or GPRS network correction interface etc) is required for the reception and interface of the correction signals to the RTK GPS / GNSS solution.

Machine pitch and roll is monitored with the use of a precision dual axis sensor. This gives an accurate indication of the machine dual axis profile which is necessary for correct placement of the machine within the terrain model. The pitch and roll is typically mounted at a protected position on the floor inside the cab.

Machine direction is monitored using an interface to detect the activation of forward / reverse signals within the machine. This sensor ensure that the machine is as displayed on the onboard computer is facing in the correct direction.

Computer / Display–mounted to the right within Reach of the operator

Roof mounted GPS antenna–fitted using high strength magnetic mount

Network Radio–also mounted using high strength magnetic mount

Other major components of the machine control system are :

1. Computer / Display located at the operator station—self explanatory, this provides the data processing and operator interface.
2. Network Radio—if a telemetry option is required with the data being transferred in real time between the machine and office (command and control type application) then a network radio is required.

Repeater Installation

Due to the size and topology of the site a repeater station for the radio mesh network may be needed. This is typically installed on a trailer (so it can be moved around the site as necessary) and in the example shown is powered by marine grade lead acid batteries which are charged via a 135W solar cell.

The repeater is placed in line of site of the office and the compactor.

As the repeater is mobile it can be moved as dictated by site development to protect against loss of communication during normal operation.

With all the components installed the only additional procedure is to ensure that the critical machine data is measured and entered into the system and the sensor (dual axis) calibrated. The measurements are very few and are only required for the system to place the RTK antenna relative to the wheel base and the dozer blade. With regards to calibration the slope sensor needs to be referenced with the machine sat still on a level surface.

Landfill Machine Control in use

To really appreciate the system you need to see it in use as a written explanation does not do it justice. As a compromise I have added the following extract of an account that I have previously given based on a site visit to see landfill machine control in action :

It is only when you see this in operation that you realise just how powerful this is by giving the site manager all the real-time (or historical) data he needs in an instant, and can even remotely control the computer in the compactor including updating software, projects, data management and messaging the operator. Having the ability to remotely monitor and message from the

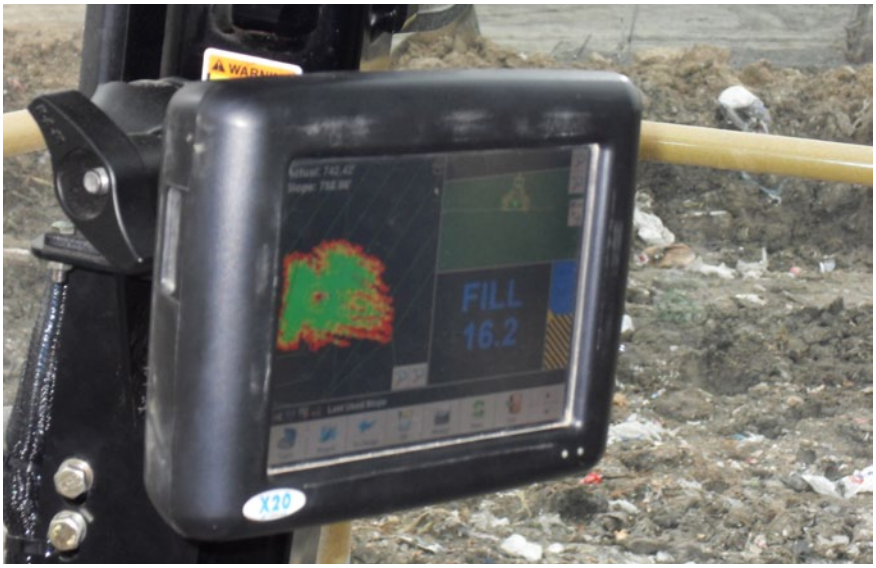
Repeater station undergoing installation.

site office is of huge benefit when trying to verify the install and system operation, yes the system could be installed without this option, but it would require a lot of trips between site office and machine.

When the installation of machine and office was completed the compactor was set to work. An existing cell was being filled and the compactor was needed to fill and compact the cell to known depth and slopes. The slopes are easily designed and entered in to the system, it is these slopes that ensure that landfill water is correctly managed. Erosion and leachate control are two of many considerations when creating the landfill, it is definitely not just about filling a hole as I had originally thought ! The compactor is required to fill in 2 ft steps. That is, the landfill is created in layers 2ft deep as this is considered to be the optimum depth for gaining maximum compaction with minimum passes. This layering is monitored with Landfill Grade by setting the system to operate with 2 ft "lifts" (this is the layer). When a lift is completed then the next 2ft lift is selected and the landfill cell is correctly filled for optimum compaction. This lift operation works in parallel with the slope function ensuring the cell fill is to design. When the cell fill is approaching that of the 3D design then the operator just finishes the fill to the shown outline. This particular site had many wells in place and these need to be protected from damage during compaction. Landfill grade allows watch and avoidance zones to be programmed into the design and will warn the operator if he approaches or gets too near the zone.

All data is recorded and can be displayed to the operator in a variety of formats, the most useful being compaction or pass count. As the display is updated in real time he can see if he has met the number of pass counts / compaction level and if there are any soft spots. Soft spots can be very damaging to the landfill design as if they are not caught early then they can be a major source of subsidence later on in the life of the landfill.

Landfill compaction in action.



All essential information is delivered to the operator via the in cab control unit.

I hope this article has given an appreciation of landfill machine control from the system and user perspective. My next article will conclude with look at the office software suite and the benefits and payback achievable in implementing this system. MC

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