MAKARIOS

GEOTECHNICAL DYNAMICS (PTY) LTD

HIGH ENERGY IMPACT COMPACTION

IN CONJUNCTION WITH

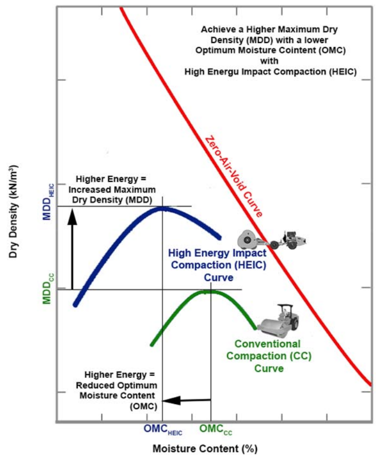
LANDPAC

HEIC

HIGH ENERGY IMPACT COMPACTION

High energy impact compaction involves the transfer of compaction energy into the soil by means of the lifting and falling motion of non-circular rotating masses. The rotation of such masses to their highest point results in an effective potential energy build-up. Further rotation of these masses results in the conversion of this potential energy into a falling kinetic energy, which is transferred to the soil upon the impact of the lowest point of the masses with the surface of the soil. The amount of energy transferred, in the form of compactive effort, is closely related to the amount of potential energy generated in the lifting process.

Features of HEIC



HIGHER COMPACTION LOADS

- Typical compaction loads of 1200-2500kN.

WIDER MOISTURE RANGE

- Ability to compact the material to a higher maximum dry density.
- Ability to compact over a wider range of moisture content, particularly drier of OMC.

INCREASED DEPTH OF INFLUENCE

- Higher surface contact pressure coupled to a relatively large contact area leads to a vastly increased depth of influence.
- Ground improvement is typically measured to effective depths of 5 - 10ft (1.5- 3.0m); with maximum depth of influence of 16 - 20ft (5.0 - 6.0m).

INCREASED SOIL COMPRESSIBILITY

- The energy is transferred in the form of a "rolling impact" resulting in a relatively longer load duration, leading to a softer soil response to the load and hence an enhanced soil compressibility is achieved.

IMPROVED COMPACTION PRODUCTIVITY

- Higher operating speeds and increased depth of influence result in higher productivity.

TOTAL COVERAGE

- The split mass configuration and the compaction process adopted results in 100% compaction coverage of the project site.

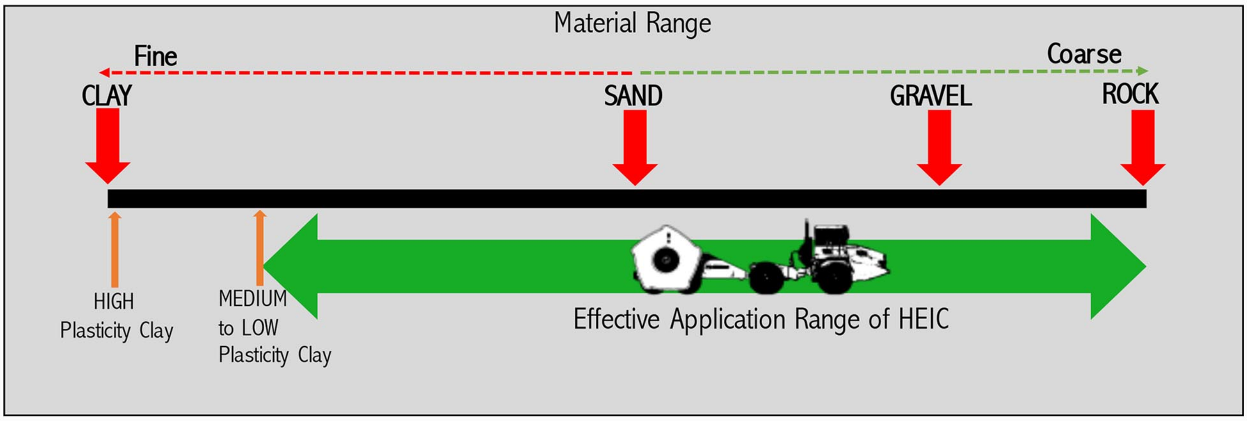
Foundation is generally 6 - 10% of the project cost and yet foundation failure is potentially the single greatest risk to long term serviceability. The cost to remediate failures can easily exceed initial construction and installation costs. Foundations need increased bearing capacity with a reduction in soil erosion and liquefaction risks, including total and differential settlement post construction. High Energy Impact Compaction offers an economic solution in addressing these concerns.

Typical Applications of HEIC

Some typical applications of HEIC include:

- Deep In-Situ Compaction
- Thick Lift Compaction
- Pavement Rehabilitation
- Compaction of Rockfill
- Proof Rolling
- Rehabilitation of Quarries and Mines
- Treatment of Unsurfaced Roads
- Coal Discard Compaction
- Treatment of Dry Sandy Materials
- Treatment of Collapsible Materials
- Treatment of (Dredged) Marine Sands
- Permeability Reduction
- Accelerated Consolidation
- Compaction of Landfills/Brownfields Rehabilitation

Application Range



Benefits of HEIC

Some typical benefits include:

1. 40-60% saving in Water requirements – the higher impact energy allows for the maximum dry density to be achieved at moisture levels below OMC. Compaction at 2-4% below OMC is possible.

2. Increase the size of the layerworks from the conventional 150-300mm to between 500mm and 1000mm. The net effect is an improved strength profile and increased production per shift per unit of:
    - o 1.65ft (500mm) Layer : 6,500 – 8,000 m^2
    - o 2.5ft (750mm) Layer : 5,000 – 6,500 m^2
    - o 3.3ft (1000mm) Layer : 4,000 – 5,500 m^2

3. Increased rockfill layers with HEIC not only improves the strength profile and increases productivity but also has the added benefit in that it reduces the amount of crushing required to reduce the maximum particle size. Increased rockfill layers allows for increased particle sizes, up to $2/3^{rds}$ the thickness of the layer.

4. The increased depth of influence in in-situ compaction may eliminate the need to excavate and replace material in thin layers.

5. Potential reduction in design layer thicknesses, even complete layers, with improved bearing capacities achieved through deep in-situ compaction.

6. Reduction in "black-top" thicknesses due to increased bearing strength achieved through deep in-situ compaction and improved compaction of layers.

7. Compaction of a wide range of materials over wider range of moisture content.

8. Improving existing on-site materials, eliminating the need to import expensive material.

9. Employment of an improved quality control technique (CIR) resulting in improved accuracy and an increased number of correlated results whilst reducing the time required to test and the time required for the results to be made available.

Markets

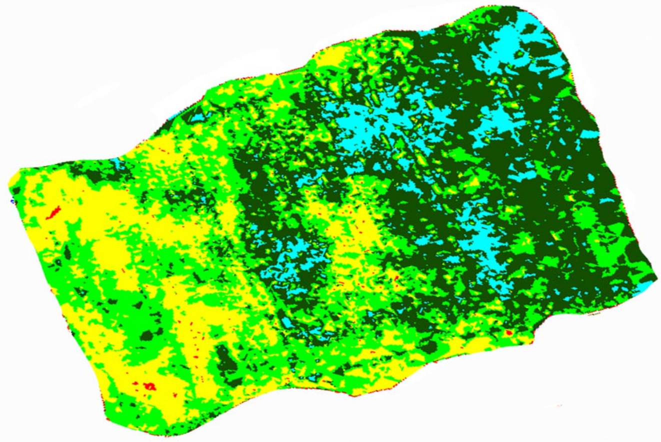
Typical Market applications include:

- Mining Industry
    - Mine Access Roads
    - Mine Haul Roads
    - Tailings/Slimes Dams
    - Platforms/Foundations
    - Coal Discard Compaction
    - Quarry Rehabilitation
    - Mine Waste Management
- Container Terminals
- Infrastructure Development
    - Roads and Highways
    - Airport Runways and Structures
    - Ports and Harbour Expansions
    - Rail networks
    - Unsurfaced roads
    - Pavement rehabilitation
- Brownfields Rehabilitation
- Environmental Applications
- Petro-Chemical Industry
- Retail and Commercial Developments
- Forestry
    - Unsurfaced Roads
- Residential Developments
- Parks and Recreation
- Power Industry

CIR LANDPAC CONTINUOUS IMPACT RESPONSE

Background

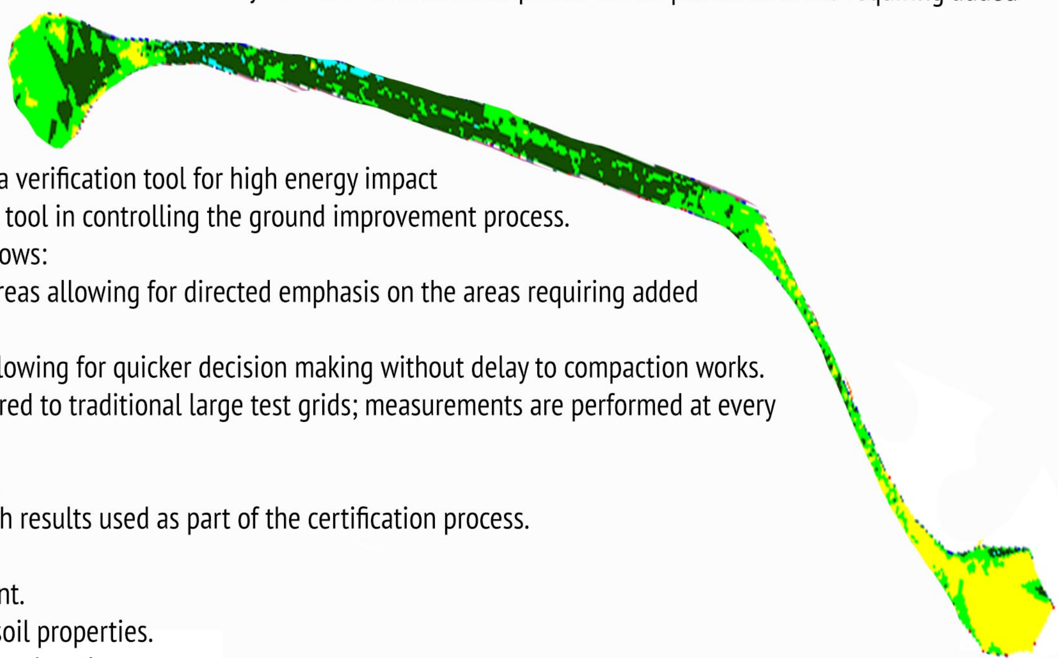
The LANDPAC Continuous Impact Response (CIR) Verification System measures the peak decelerations (the soil's response) of every impact of the roller, allowing a direct measurement of soil stiffness. Each of these stiffness measurements are recorded relative to its individual position on site, as determined by an integrated global positioning system.



Correlation

These accurately measured and recorded decelerations are then correlated back to a direct measurement of engineering properties as measured by conventional testing methods, including density measurements, penetration testing (CPT, DCP, SPT,etc) and direct load testing (Plate Load, Zone Load, etc). In doing so, the CIR system can be used in conjunction with conventional testing techniques to provide a quality assurance system capable of certifying the entire site at a reduced cost and an increased level of certainty. The strength of the correlation is measured by means of the correlation coefficient (R^2). The correlation coefficient is a measure of the strength of the relationship between the two variables. As the process continues, occasional conventional testing will allow the accuracy of the correlation to be verified, so as to ensure that correlations used are specific to the properties of the material used.

Once accurate correlations are established, colour coded limits are established with the controlling engineer on site, based on specification requirements, and the net result is a deceleration and a predicted soil property mapping of the entire site, at various stages of the compaction process. Improvement is immediately visible and directed emphasis can be placed on areas requiring added improvement.



Advantages

The system is currently widely used as a verification tool for high energy impact compaction, proving to be a very useful tool in controlling the ground improvement process.
The advantages are summarized as follows:

- Accurate identification of weaker areas allowing for directed emphasis on the areas requiring added improvement.
- Immediate availability of results allowing for quicker decision making without delay to compaction works.
- Increased measurements as compared to traditional large test grids; measurements are performed at every impact (900mm).
- Quality Control during compaction.
- Quality Assurance on final pass, with results used as part of the certification process.
- Verification of the entire site.
- Quick and inexpensive measurement.
- Direct correlated measurement of soil properties.
- Ability to control a site from a remote location.
- Greatly reduce the risk relative to the verification of soil properties during the compaction process.

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