LANDPAC®

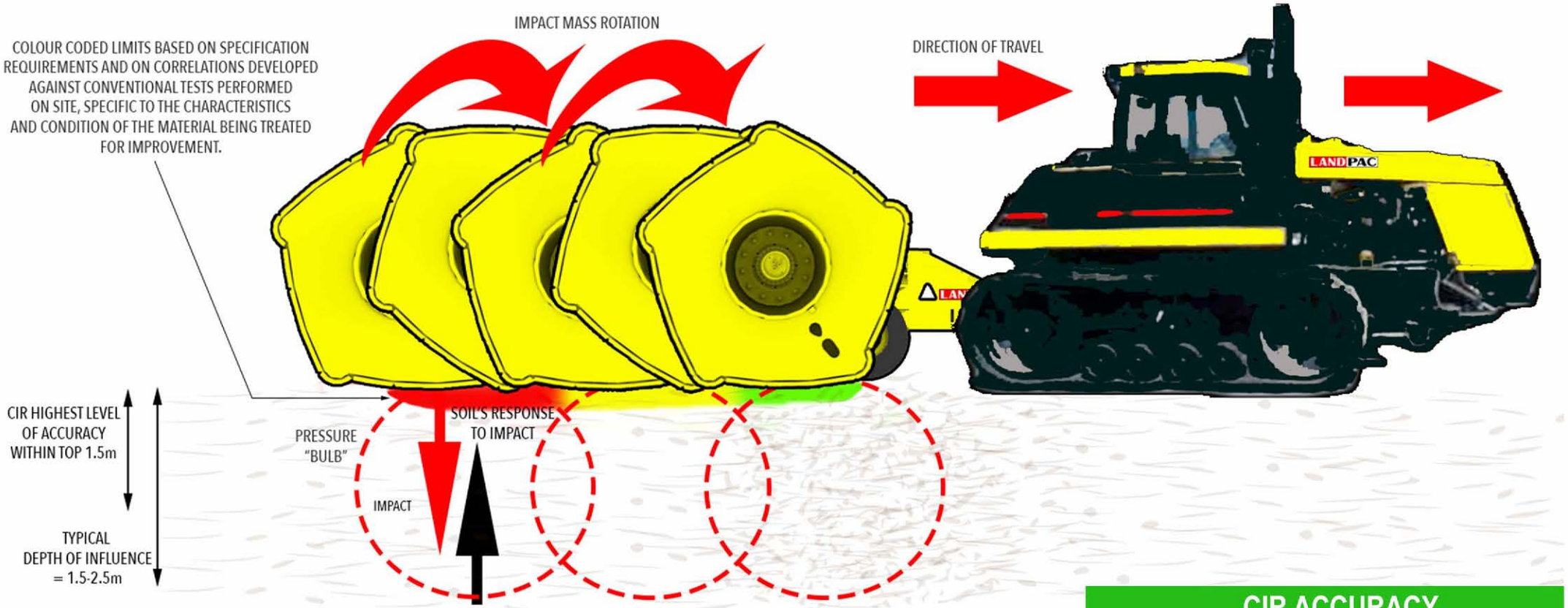
GROUND ENGINEERING

CIR

CONTINUOUS IMPACT RESPONSE

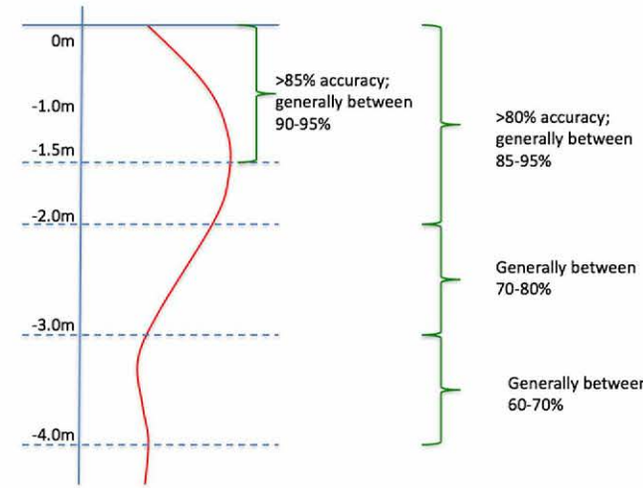
GROUND IMPROVEMENT VERIFICATION

BASIC EXPLANATION



MATERIAL	LOOSE MATERIAL; SOFT MATERIAL; LESS STIFF; HIGHLY VOIDED MATERIAL	DENSE MATERIAL; HARD MATERIAL; STIFF; MATERIAL WITH LITTLE TO NO VOIDS
RESPONSE TO IMPACT	SOFT/LOW SOIL RESPONSE TO THE IMPACT (SOIL ABSORBS SOME TO MOST OF THE IMPACT)	HARD/HIGH SOIL RESPONSE TO THE IMPACT
DECELLERATION	LOWER DECELERATION RECORDED	HIGHER DECELERATION RECORDED

CIR ACCURACY

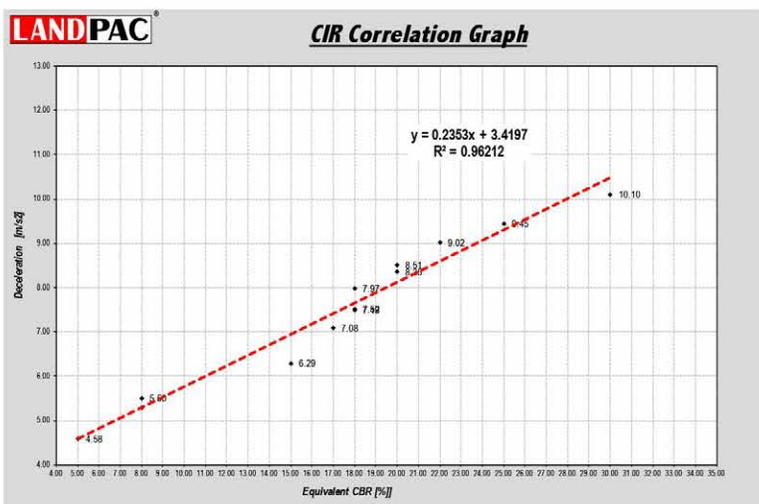


BACKGROUND

The Continuous Impact Response (CIR) System is a system capable of measuring the soil response to every impact of the roller, resulting in a direct measurement of soil stiffness, which is a function of the soil density. The CIR measures peak decelerations of the compaction masses with each impact. Each of these points is recorded relative to its position on site as determined by an integrated global positioning system. These accurately measured and recorded decelerations are then correlated back to a direct measurement of engineering properties.

CORRELATIONS

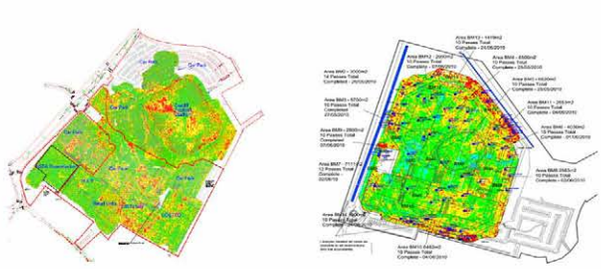
CIR measurements can be very accurately correlated to all conventional testing methods including density measurements, penetration testing (CPT, DCP, etc) and direct load testing (Plate Load, Zone Load, etc). In doing so, the CIR system can be used in conjunction with conventional testing techniques 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 LANDPAC to verify the accuracy of the correlation so as to ensure that correlations used are specific to the properties of the material used.



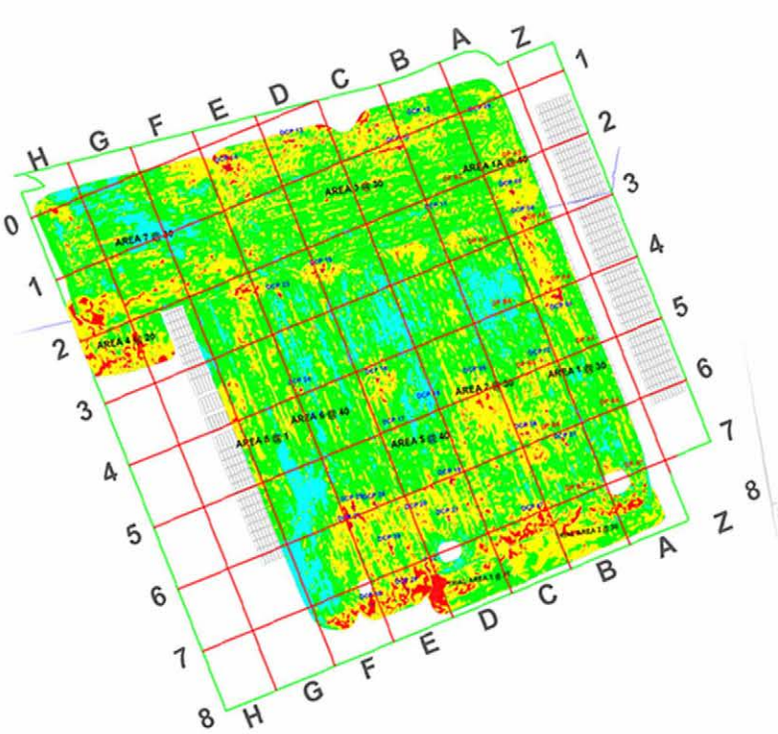
A Typical Correlation Graph (Correlation performed between CIR measurements and Equivalent CBR, derived from standard penetration tests)

LIMIT SETTING

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.



Typical CIR Mappings



COLOR CODING & MAPPING

By using this colour coding and all of the measurements generated by the CIR measurement system, it is possible to generate coloured "maps" of the entire area being treated by HEIC. These maps then clearly identify the relative strength of the entire area and serve to highlight the following:

- Green areas: these areas are likely to exceed engineering requirements of strength and stiffness and do not require any further conventional testing.

- Yellow Areas: these areas could need some further investigation with conventional testing to verify their acceptance relative to the engineering requirements.

- Red areas: these areas are likely to fall short of engineering requirements and would require specific investigation with conventional testing with a view to further ground improvement treatment or remediation if required.

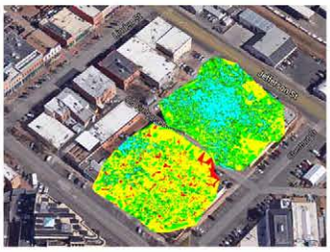
A CIR "hand-over" sheet is be completed and handed over to the controlling engineer on site for review and approval after each and every section is completed. Such CIR "hand-over" sheets will show the CIR property mapping for the identified compacted section and will provide additional information allowing decisions to be made.

CIR being used to verify layerworks improvement on a mass earthworks project

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 (1 meter/3.3 feet).
- 2400 readings are recorded every 3 feet by 3 feet area giving 100% verification of the site.
- 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.



CIR Mapping on a Commercial Development

The CIR Verification System is fitted to all configurations of LANDPAC High Energy Impact Compactors