TECHNOLOGY

Dynamic Compaction (DC)

TREVI GROUND ENGINEERING

Dynamic Compaction for Polymer Additive Plant project- (2014) Abu Dhabi- UAE
Client: Songwon Additive technologies

Dynamic Compaction (DC) is a Ground Modification technique whereby loose soils can be effectively and economically densified to improve its mechanical characteristics and allow construction of different types of structures without need of deep foundations or soil replacement. The method involves dropping a heavy steel pounders repeatedly on the ground at regularly spaced intervals. The weight and height of pounding depends on the degree of compaction desired. The usual range of pounder is between 12 ton to 25 ton and the drop height can be up to 25 m.

Dynamic Compaction (DC) method is applicable for a wide variety of soil conditions including saturated/unsaturated loose Sands, even with the presence of silty pockets, dune sands, inorganic fill, reclaimed soils with variable characteristics and sizes even with the presence of large sized boulders, landfills deposits and

- Applicable for wide range of soils with fines content up to 35%, down to significant depths up to 10 m
- DC is the fastest soil improvement method (more than 30,000 sqm/crane/shift/month)
- Well adapted to large scale projects
- Increases the bearing capacity of soils, reduces the post-construction settlements and eliminates the risk of liquefaction in case of seismic events
- With a global treatment of the ground, DC works can be undertaken ahead of the foundation design
- Very sustainable technique: no disposal, no cement, no aggregate...

collapsible soils.

Dynamic Compaction (DC) has been extensively used to compact loose soils to depths of up to 10 m, in order to increase the bearing capacity, decrease post construction settlement and mitigate liquefaction risk in case of seismic events.

Dynamic Compaction (DC) can be safely executed as close as 30-50 m from existing/under construction structures or concrete/civil works, without generating any undesirable vibrations.

Special measures may also be taken to further reduce this distance such as decreasing the compaction energy or creating a surface trench to cutoff the propagation of surface waves created by the pounder impact.

Wide range of applications

Thanks to its cost effectiveness, high productivity and suitability, Dynamic Compaction (DC) technique is well suited for wide range of applications and projects with different sizes up to several million sq.m, covering Industrial buildings, Oil & Gas facilities, Infrastructure constructions, Platforms and logistics facilities, commercial and residential buildings, tanks, artificial islands, road and railway embankments, land reclamations ...

Dynamic Compaction (DC) technique was implemented as value engineering alternative to deep foundation or soil replacement, for a large number of structures throughout the world .

Some major references of TREVI are listed hereunder:

Dadin Kowa Dam Project,
Nigeria (1981)

Client: Upper Benue River Basin Development Authority

Intermodal Station of Busto Arsizio
Goods stocking area, Italy (1990)

Client: FF.SS. Italian Railway Authority

Dammam correction facilities project,
Saudi Arabia (2012)

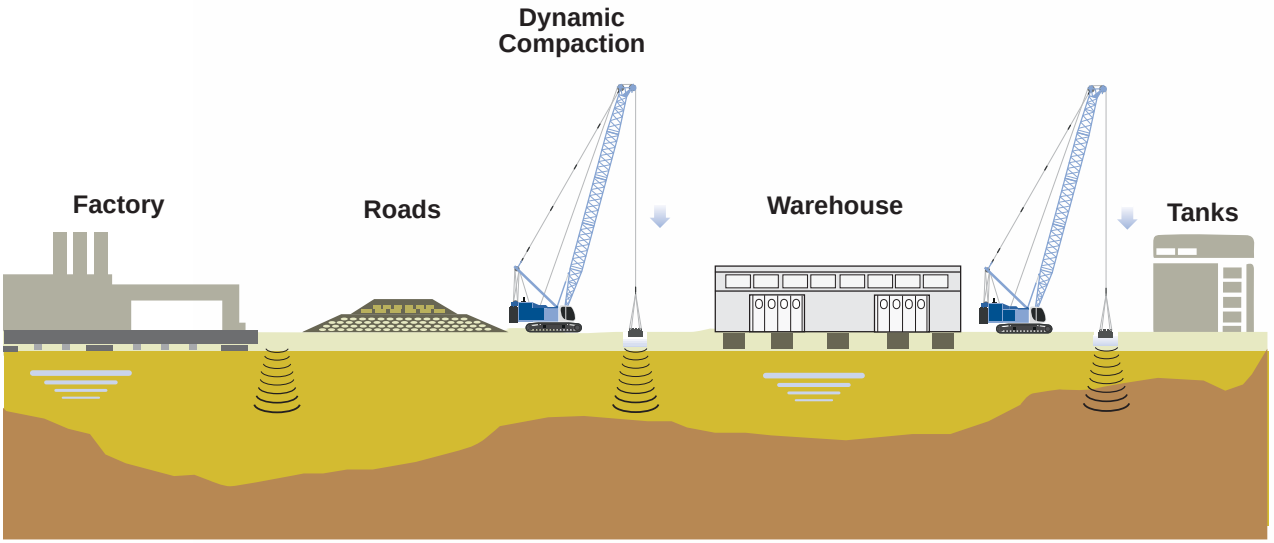
Client: BenLaden Group (ABCD)

Area: 1,600,000 m^2

CTW 110 project
Railway between jubail and Ras Al Khair Project, Saudi Arabia (2014)

Client: Saudi Railway Company (SAR)

Total Area: 1,000,000 m^2

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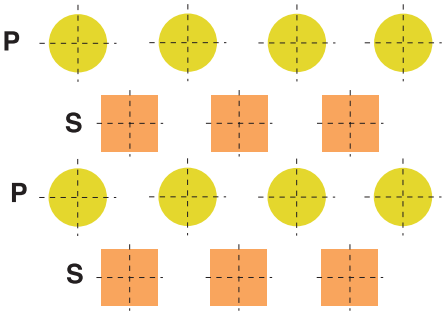
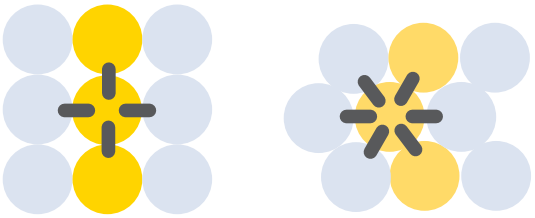
Phasing

The energy is applied to the ground in several blows for each impact position and in several passes, following a preset grid (usually a square grid), split into Primary grid (P) and secondary grid (S) .



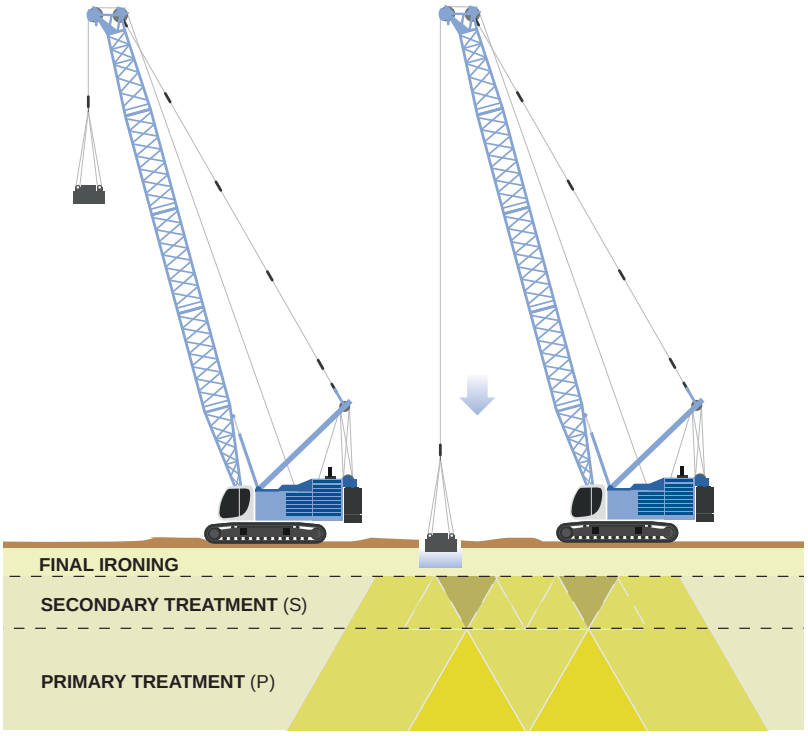
The impact of the falling weight results in a series of actions:

- Immediate densification of the granular soils;
- Generation of a compression wave that builds up pore water pressure causing total or partial liquefaction;
- Generation of high energy shear and surface waves that result in the densification of soil through the re-arrangement of the grains;
- Creation of a shear failure plane that acts as a preferential drainage path and hence speed up the consolidation process.



Prior to commencement of actual soil improvement works, a specific calibration area should be carried out at site, to confirm the suitability of DC method to the project conditions and optimize the design parameters (i.e. number of blows, height of drop, grid spacing...etc), to be used during production stage.

Calibration works consists of performing pre-tests to assess the soil strength before compaction, heave & penetration tests to evaluate the ground response during compaction and then post-treatment tests to confirm the achievement of project criteria.



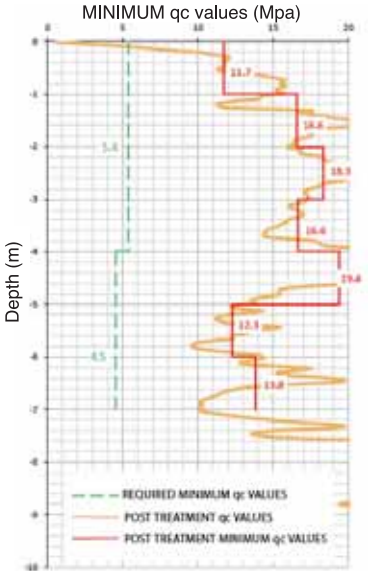
Dynamic Compaction for Titanium Dioxide Slag Smelter Plant (2013), Jazan Economic City Al Baish - KSAClient : Cristal

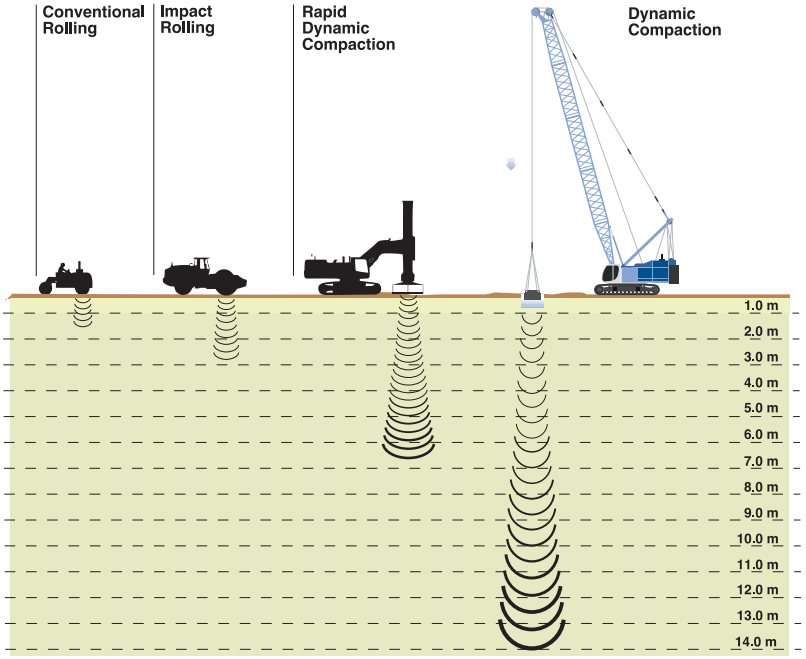
Implementation of DC

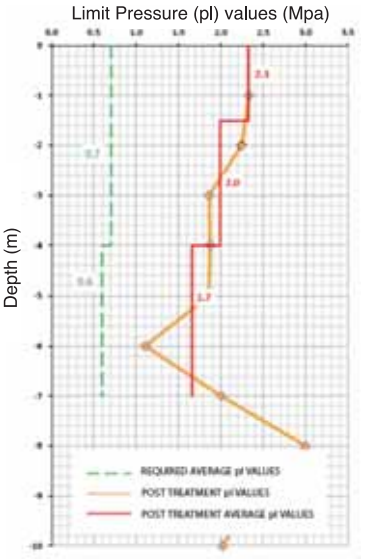
Dynamic Compaction (DC) is a real time adjustment technique, whereby all production parameters are fully recorded, controlled and adjusted during production stage. A detailed quality assurance procedure is implemented during DC works, which relies on:

- An automated record of all production parameters (drop height, weight of pounder, print reference, number of blows, number of passess, final penetration...);
- A continuous record of ground response during compaction (ground settlement, ground heave, upward water follow, visual inspection of ground surface...);
- A systematic assessment of the achieved soil characteristics using pressuremter and cone penetration tests.

This systematic control guarantees that the whole area meets the project requirements in terms of bearing capacity, post-construction settlement and liquefaction, at every treated point.

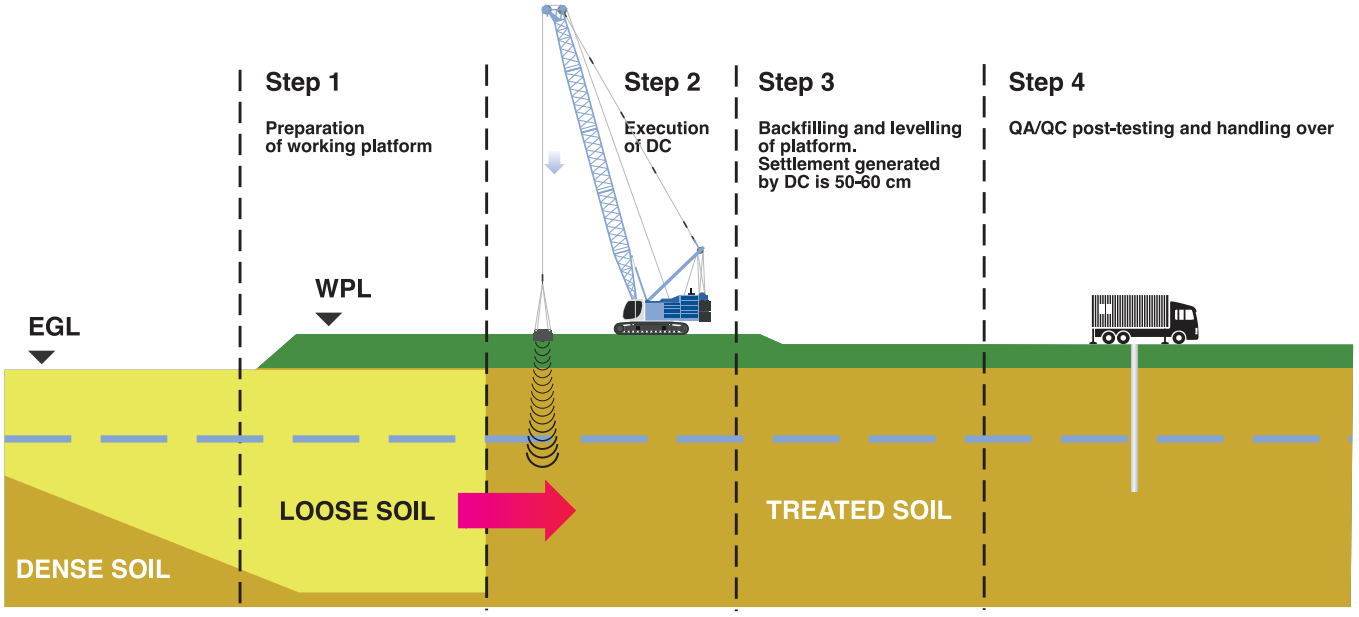






CPT-qc and PMT-pl achieved results after implementation of DC technique for compaction of loose sand.

Dammam Correction Facilities project, KSA (2013)



Other applications

Fill Compaction

DC is a very effective method for fill compaction of granular materials including: *Engineering fill, dune sands, dredged materials ..., with very flexible specifications comparing to other classical compaction methods.*

The most interesting aspect of using DC for compaction of fill is that many meters of fill can be placed and then compacted “in one go” instead of compacting in thin layers, as per in traditional roller compaction.

The main advantages of DC comparing to the traditional method, are :

- **Fast production:**
more than 40,000 m^2/month/crane/shift;
- **DC is very economical** in comparison to roller compaction, especially for deep fills
- **Very flexible specifications** for the backfilling materials

Rapid Dynamic Compaction

Rapid Dynamic Compaction (RDC) technique is a recently developed soil improvement technique, used for compaction of granular soils up to 5 m deep, as alternative to DC method.

The RDC machine consists of a hydraulic excavator base with a strengthened arm to which a strengthened arm to wich a compaction hammer is attached.

The compaction energy is generated by the fall of a 12-16 ton hammer from height of up to 1.2 m.
The hammer falls on a compaction foot having a diameter ranging from 2.0 to 2.6 m, in contact with the ground and the energy is in turn transferred to the ground.

The compaction of the subsoil is initiated by the vibrations generated by the impact of the weight upon the foot, and by the movementof the foot into the ground pushing the material into a denser structure.

RDC technique is well adapted to be used in combination with dynamic compaction and vibro dynamic compactio techniques in order to improve the surface soil.

RDC techniques generated limited vibtrations comparing to dynamic compaction technique and thus can be used close to existing structures.

Equipment

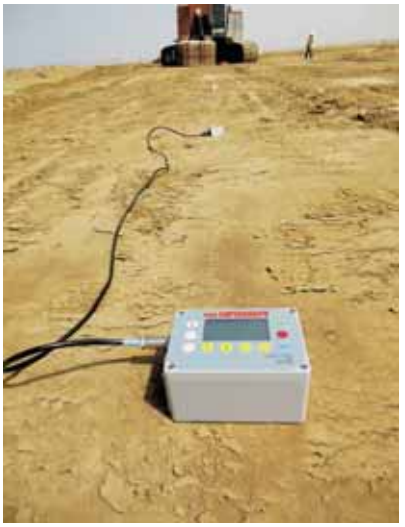
Heavy DR crane type soilmec SC120

Testing Equipment

Geomil-CPT mounted truck


Vibration measurement device type Nomis


PMT rigs




Dynamic Compaction for reclaimes soil - Zamil Shipyard project Dammam-KSA (2013)
Client: Zamil Offshore

Protagonista mondiale nel settore dell'ingegneria nel sottosuolo, Trevi ha consolidato, in oltre 50 anni di attività in ogni angolo del mondo, la propria capacità di risolvere qualsiasi problema d'ingegneria nel sottosuolo.
Trevi opera nel settore della fondazioni speciali, nel consolidamento di terreni, nel ripristino delle dighe, nella costruzione e consolidamento delle gallerie, nei lavori marittimi, nella messa in sicurezza dei siti inquinati, nella costruzione di parcheggi interrati e automatizzati.
Trevi è votato all'innovazione continua e alla costante ricerca di soluzioni per le complesse problematiche che l'ingegneria civile deve affrontare in tutto il mondo. Sperimentazione della tecnologia più avanzata, tradizione imprenditoriale e volontà di investire in ricerca e nelle risorse umane sono i punti di forza di una realtà radicata in oltre 30 paesi.

Trevi is a worldwide leader in the field of foundation engineering.
In over 50 years of activity in every part of the world, Trevi managed to consolidate its own capability in solving any problem related to underground engineering. Trevi is involved in the field of special foundation works, soil consolidation works, dam restoration works the construction and the consolidation of tunnels, marine works, reclamation of polluted areas, construction of underground and computer-based car parks. Trevi is devoted to the continuous innovation and the never-ceasing research for solutions to the complex problems that civil engineering has to face worldwide. Testing of the most advanced technology, entrepreneurial tradition and will to invest in research and human resources are the force points of a reality that is rooted in over 30 countries.

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www.trevispa.com
tge@trevispa.com