ASSET CONSTRUCTION HIRE PTY LTD

"Let us be an asset to your business"

Onsite Training

Compaction Basic's
D One Trench compactor
CC900 Smooth Drum Roller
CC1200 Smooth Drum Roller
CA1300 Padfoot Roller

DYNAPAC
FAYAT GROUP

What is compaction?

Soil consists of mineral particles and air voids that can be partially filled with water.

Compaction is simply to increase the density of the soil by reducing the amount of air voids and increase the number of contact points between the particles to create a load carrying ”skeleton”.

Why should compation be utilized?

Increases the load bearing capacity, decreases the permeability and practically eliminates future settlement.

A 1% increase in compaction can give an increase in lifetime of 10-15% on a road structure

Sub-standard compaction is a common cause of premature failure in many structures.

Structures


Road


Airfield


Canal


Railroad


Foundation


Earth dam

Compaction variables

Material related

Application related

Machine related

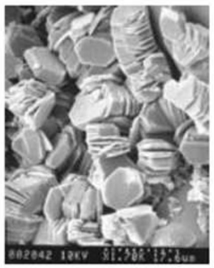
Compaction variables

Material related

Application related

Machine related

Compaction resistance mechanisms



Cohesion

Apparent cohesion

Friction

Cohesion
- Molecular forces between the particles, due to very small size of particles

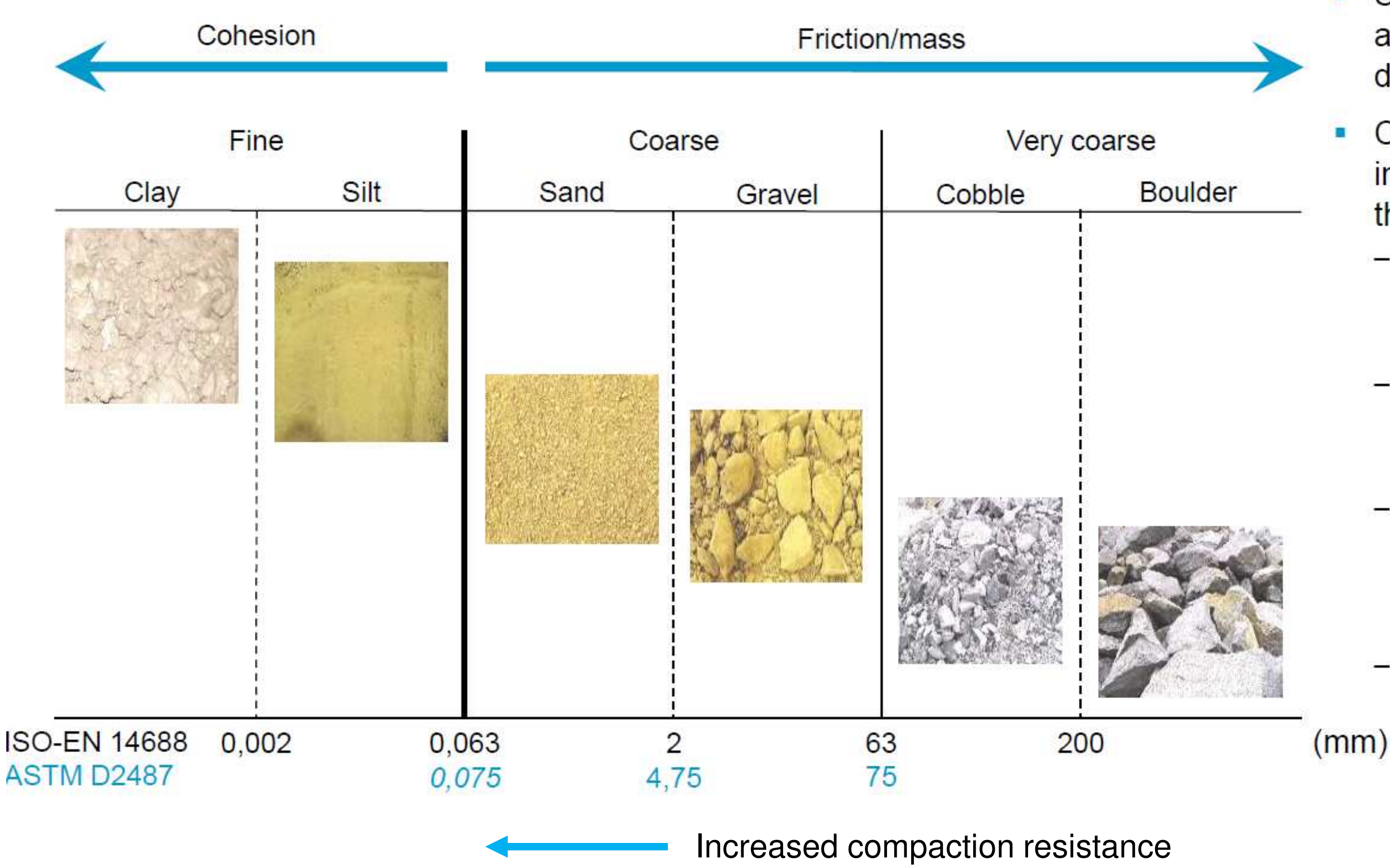
Apparent cohesion
- Capillary forces between the particles, due to a water film around the particles

Friction
- In the contact points between the particles

Mass
- For very coarse particles the mass has an influence

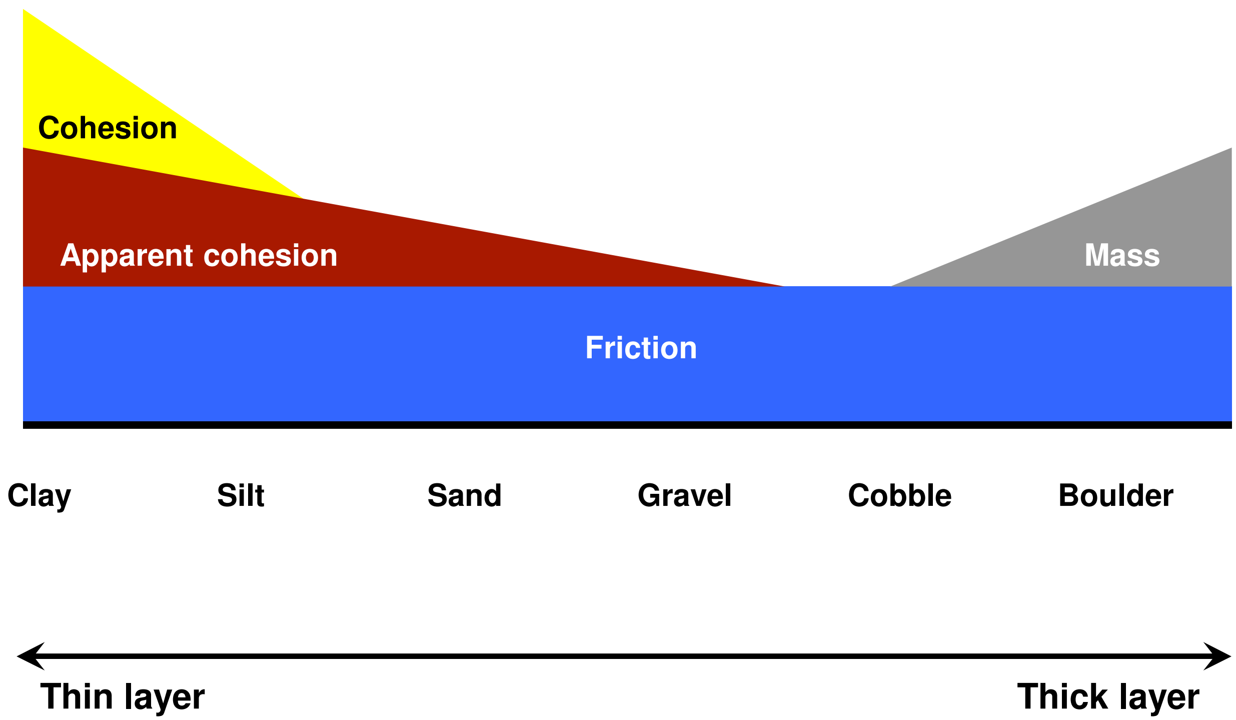
Compaction forces excited has to overcome the resistance

Main compaction resistance due to soil fraction



- Soil is divided in fractions according to the grain size distribution
- Compaction wise it is interesting to divide the soil in the following
  - Very coarse
    - >10% cobbles or >5% boulders
    - Friction
  - Coarse grained
    - < 15%/<12% fines
    - Friction and apparent cohesion
  - Mixed grained
    - 15 – 40%/12-50% fines
    - Apparent cohesion, cohesion and friction
  - Fine grained
    - > 40%/>50% fines
    - Cohesion and apparent cohesion

Resistance to compaction

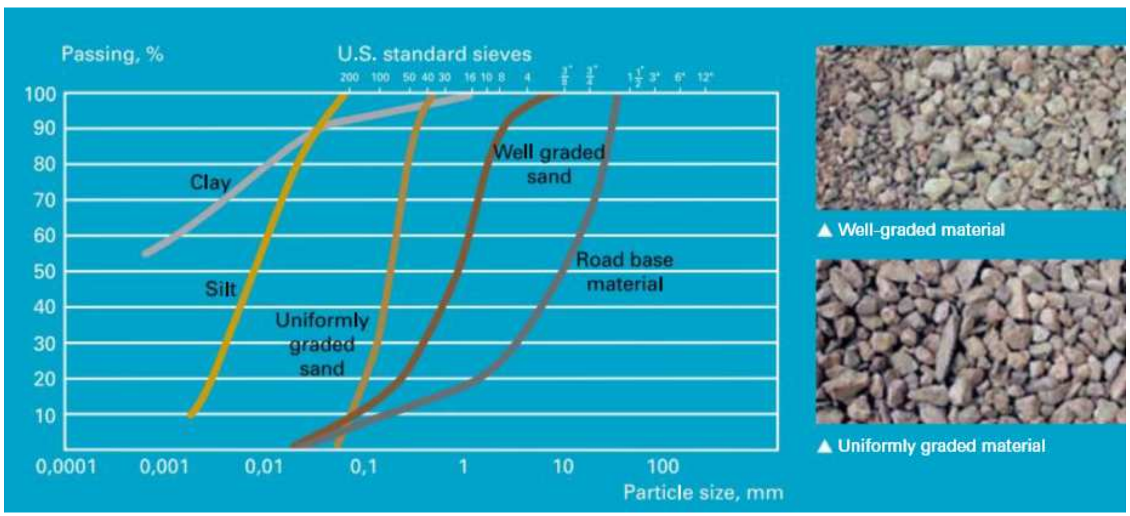


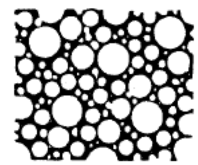
Compaction resistance mechanism summary

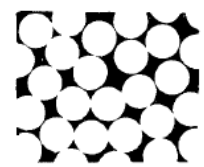
- Fine grained soils are dominated by cohesive compaction resistance.
- A soil consisting of the finest particles has a high cohesive compaction resistance. In fact, it is so high that the soils is like rock in dry condition (clay).
- The high compaction resistance in cohesive soils means that these type of soils must be compacted in thin lifts (approx. 20 cm).
- A soil with slightly larger particles is like dust in dry condition (silt)
- When it is possible to feel the single grains in the material, friction is starting to dominate the compaction resistance.

Particle size distribution

- Normally, a soil consists of several different particle sizes or fractions. The distribution of different grain sizes can be determined by sieve tests.
- The dried soil sample is passed through a number of standard sieves which differs in mesh size. The amount of material in each sieve is calculated as a percentage of the total weight of the sample and plotted in a graph.



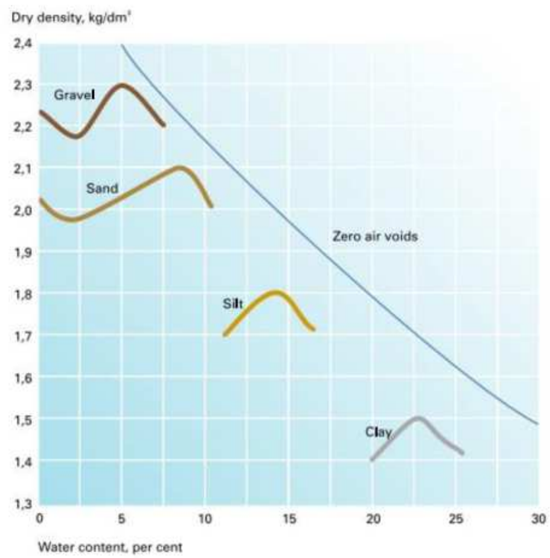




- To achieve a stiff/dense result after the compaction is finished, it is preferable to have a well graded material.

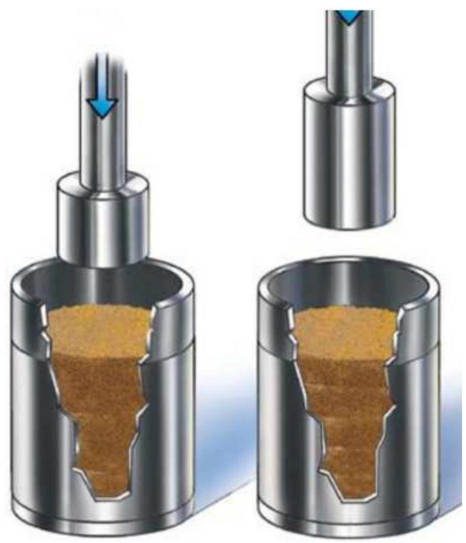
Water content

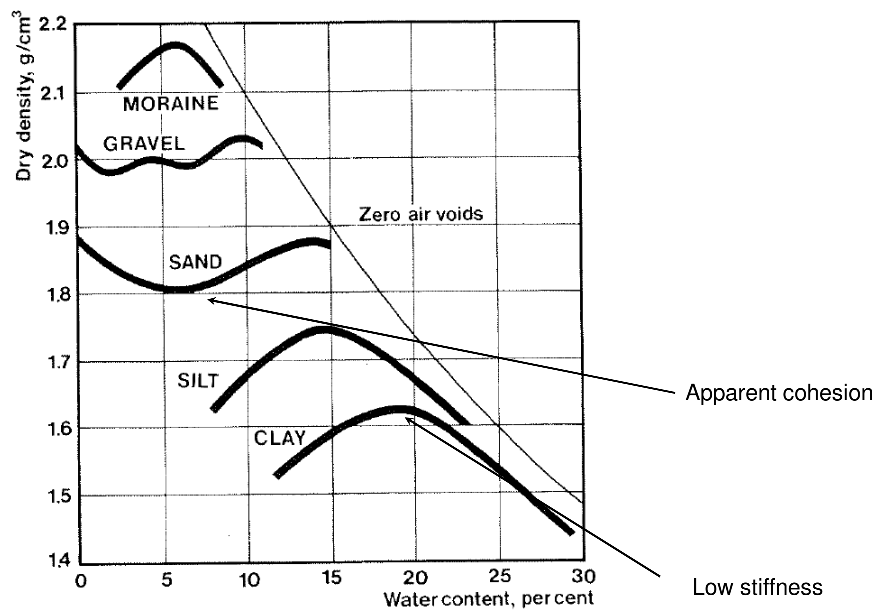
- The amount of water in the soil plays an important role when it comes to compaction resistance in soils where cohesion and apparent cohesion is the dominating compaction resistance mechanisms.
- For the same compaction method, the soil obtains different dry densities, depending of the water content when the soil was compacted. There exists an optimum water content, i.e. an amount of moisture where the highest dry density is obtained for a certain compaction method.



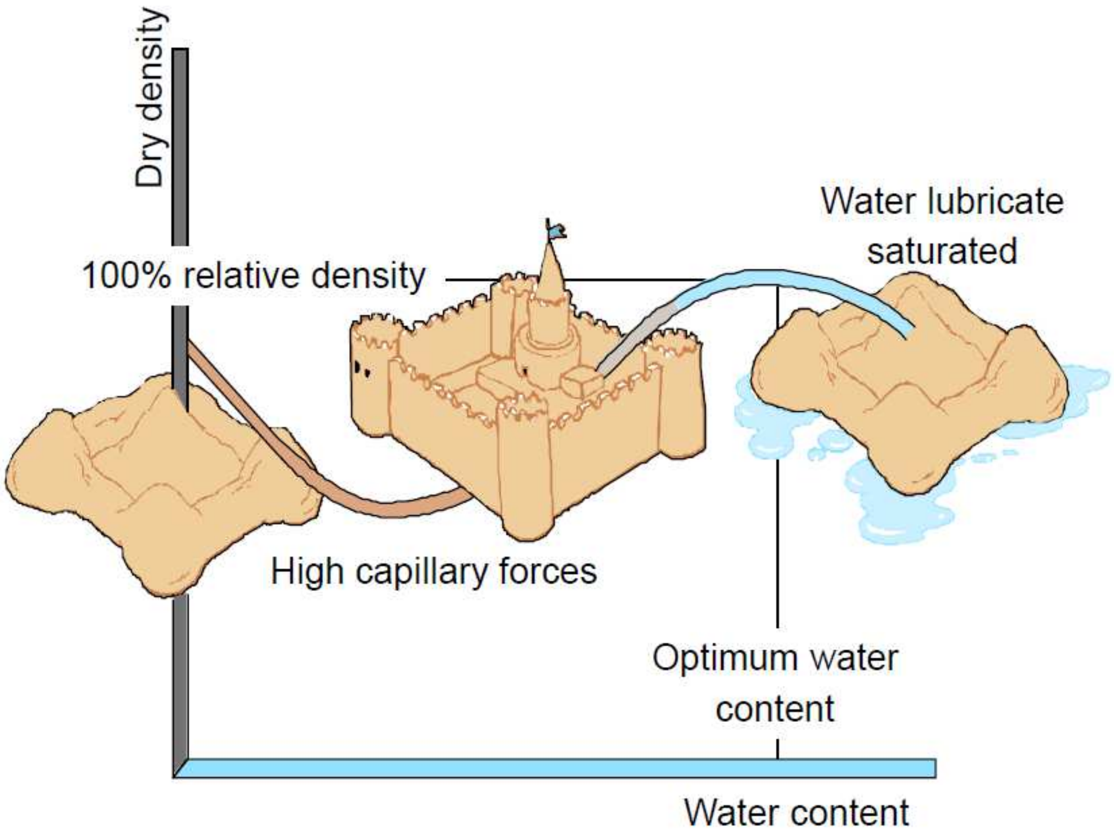
Proctor test

- A way of finding out the optimum water content of a specific soil is to perform a so called Proctor test.
- A certain amount of energy is impacted on the sample to be tested. The test has a defined starting volume, and after the impacts, the test is dried and the weight is compared to the volume of the sample.





Water content in sand



Water content

- In granular, permeable soils, so called ”free-draining soils”, the water is pressed out when the particles are relocated to a higher density. These materials are not so sensitive to moisture content.
- When the amount of fine grained fraction is above 10 % of the soil to be compacted, cohesion and apparent cohesion is dominating the compaction resistance and the soil becomes sensitive to moisture. For these types of soils, it is very important to control the water content to be able to achieve the prescribed compaction requirements. Having the wrong water content will make it impossible to compact the soil to the required density/stiffness.

Compaction variables

Material related

Application related

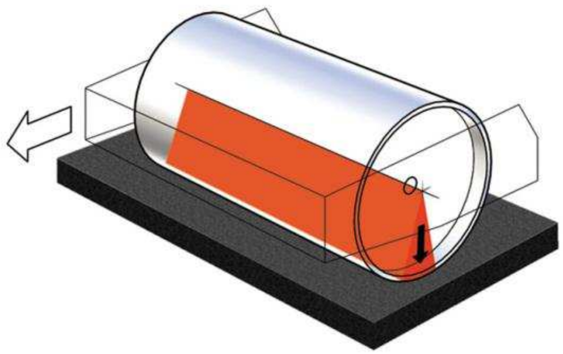
Machine related

Machine related compaction variables

- Machine weight (static linear load/contact pressure)
- Amplitude
- Frequency

Static linear load

- The weight of the drum module divided by the drum width.



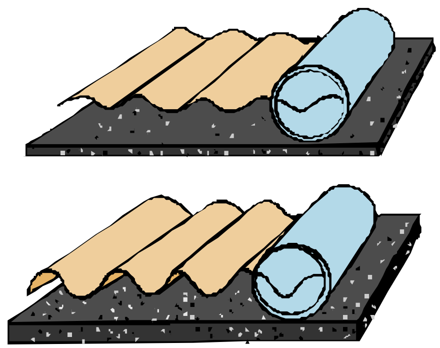
- **CC900**
- **Drum module ----1,665kg**
- **Drum Width ----90cm**
- **Linear Load ----8.4 to 9.4kg/cm**

- **CC1200**
- **Drum module ----2,600kg**
- **Drum Width ----120cm**
- **Linear Load ----10.4 to 11.4kg/cm**

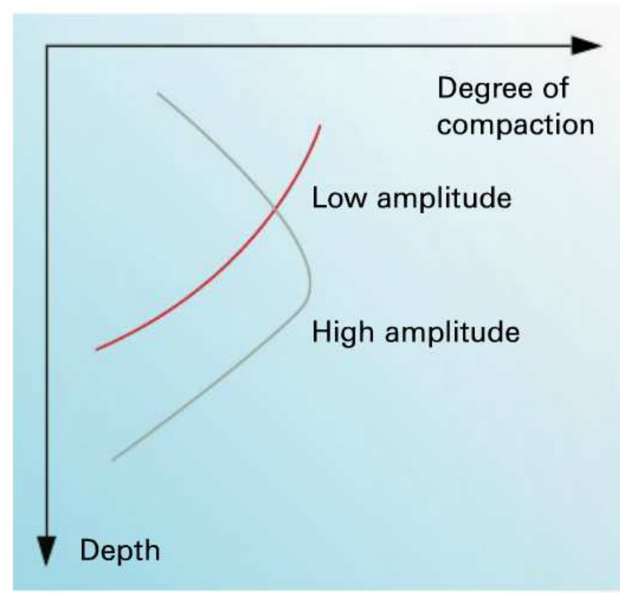
- **CA1300**
- **Drum module ----5,000kg**
- **Drum Width ----137cm**
- **Linear Load ---- kg/cm**

Amplitude

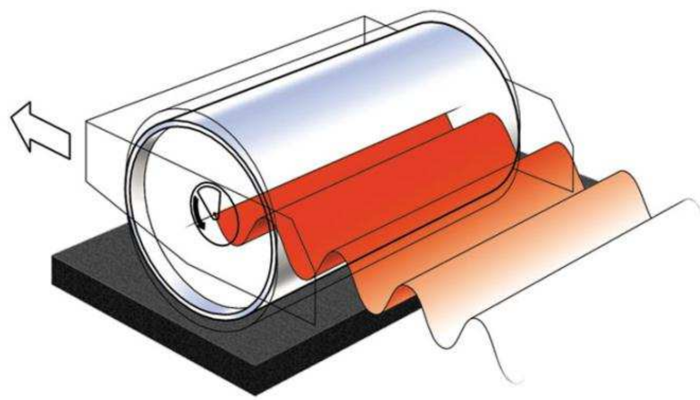
- The vibration of the drum sets the particles in motion and increases the compaction effect
- The higher the amplitude, the greater the depth effect



Amplitude



Frequency



- The frequency and amplitude need to be matched to optimize the compaction performance

Compaction variables

Material related

Application related

Machine related

Application related compaction variables

- Selected amplitude
- Layer thickness
- Number of passes
- Rolling speed
- Compaction specifications

Important compaction parameters, summary

-Machine dependent parameters:

- ✓ **Static linear load**
- ✓ **Amplitude**
- ✓ **Frequency**

-Operator dependent parameters:

- ✓ **Rolling speed**
- ✓ **Number of passes**
- ✓ **(Lift thickness)**

-Parameter not relevant for compaction:

- ✓ **Centrifugal force!**

D.One Pad Foot Trench Compactor

Masses	
Operating mass	1595 kg
Basic mass	1585 kg
Axle load, avg.	798 kg

Traction	
Speed 1, forward /reverse	1.2 km/h
Speed 2, forward /reverse	2.8 km/h
Max. gradeability without vibr.	55 %
Max. gradeability with vibr.	45 %

Compaction	
Centrifugal force (front/rear)	/
Amplitude (front/rear)	1.12/0.56 mm
Frequency	42/42 Hz

Dynapac CC900 Plus

Double drum vibratory rollers

Masses	
Max. operating mass	1665 kg
Operating mass (incl. ROPS)	1600 kg
Module mass (front/rear)	750 kg/850 kg

Compaction	
Centrifugal force	17 kN
Nominal amplitude	0.4 mm
Static linear load (front/rear)	8.3/9.4 kg/cm
Vibration frequency	70 Hz
Water tank	190 l

Dynapac CC1200 VI

Double drum vibratory rollers

Masses	
Max. operating mass	3,400 kg
Operating mass (incl. ROPS)	2,600 kg
Module mass (front/rear)	1,230 kg/1,370 kg

Traction	
Speed range	0-10 km/h
Vertical oscillation	±10°
Theor. gradeability	42 %

Compaction	
Centrifugal force	34/29 kN
Nominal amplitude	0.5 mm
Static linear load (front/rear)	10.3/11.4 kg/cm
Vibration frequency	66/61 Hz
Water tank volume	205 l

Dynapac CA1300PD w. blade

Single drum vibratory rollers

Masses	
Operating mass (incl. ROPS)	5,000 kg
Module mass (front/rear)	2,250/2,750 kg
Max. operating mass	5,200 kg

Traction	
Speed range (Dual/TC/AS)	0 -6 km/h
Tyre size (8 ply)	12,5-20
Theor. gradeability	52 %
Vertical oscillation	±9°
Number of pads	72
Pad area	53 cm^2
Pad height	76 mm

Compaction	
Nominal amplitude	1.5 mm
Vibration frequency	35 Hz
Centrifugal force	89 kN

Understanding Asphalt Compaction Graph

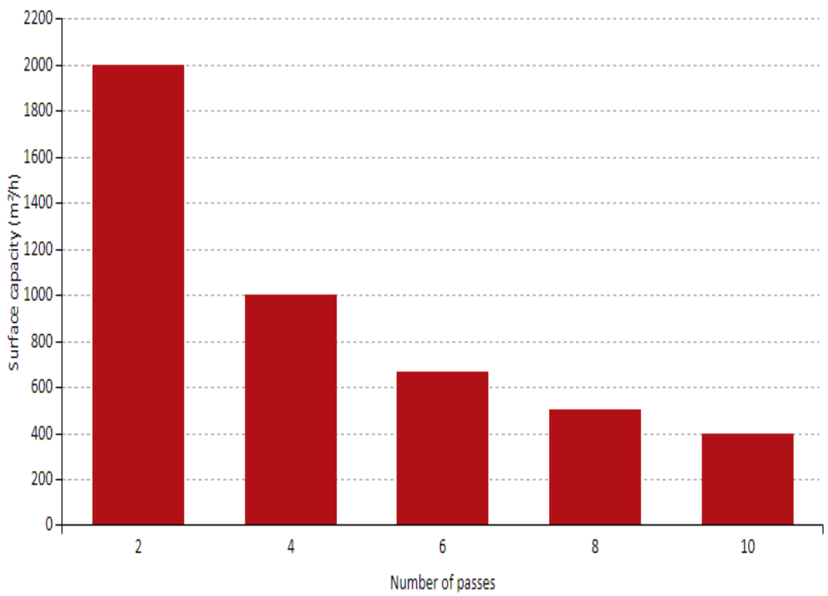
- Types of Asphalt
- Machine selection
- Recommended Layer thickness
- Minimum Number of passes required
- Estimated Capacity in Tons/Hour with the machine selection
- Surface rolling area in Square Metres/Hour
- Variables?
- Job: Driveway---3m x 50m (150 square metres) 50mm thick---(7.5 cubic metres os Asphalt)

Asphalt Graphs

COMPACTION DATA

x

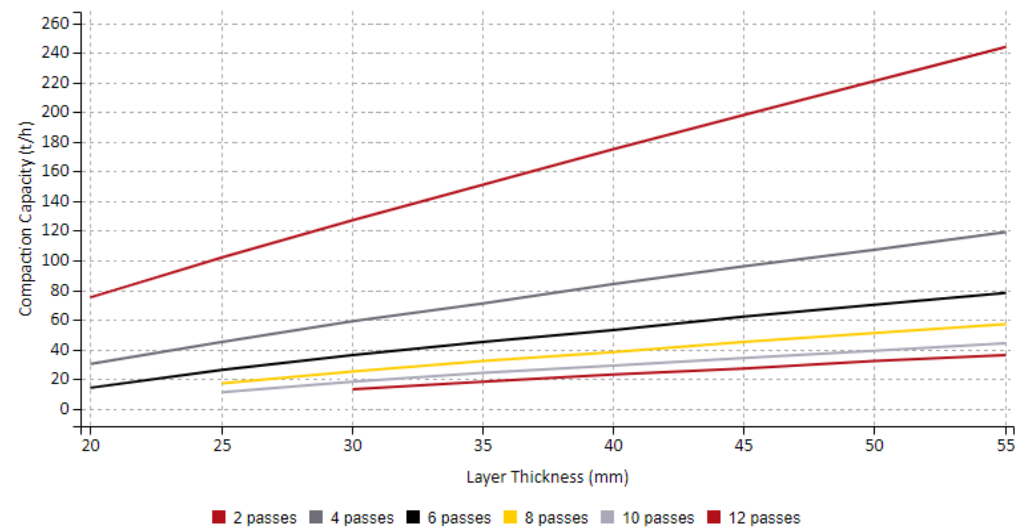
ASPHALT COMPACTION



ASPHALT COMPACTION DETAILS

ACBIND ACSURF PA ACBASE SMA

POROUS ASPHALT



Understanding Soil Compaction Graph

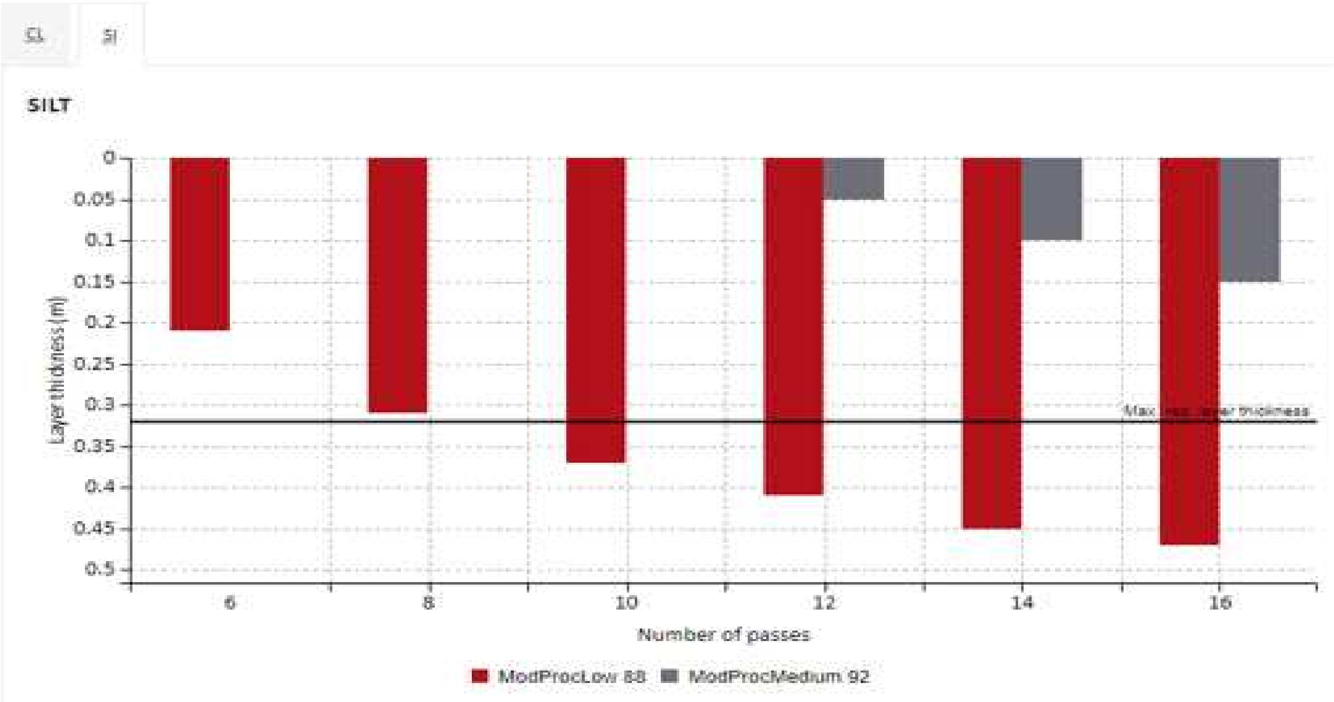
- Types of Soil/Material
- Machine selection
- Recommended Layer thickness
- Minimum Number of passes required
- Estimated Capacity in cubic metres
- Proctor % required for the Job?
- JOB---Driveway base---3m wide x 100m long (300 square metres area)

300mm base required----(90 cubic metres) 2 layers of 150mm

Estimate 10 passes ---Capacity 48 cubic metres of material/hour

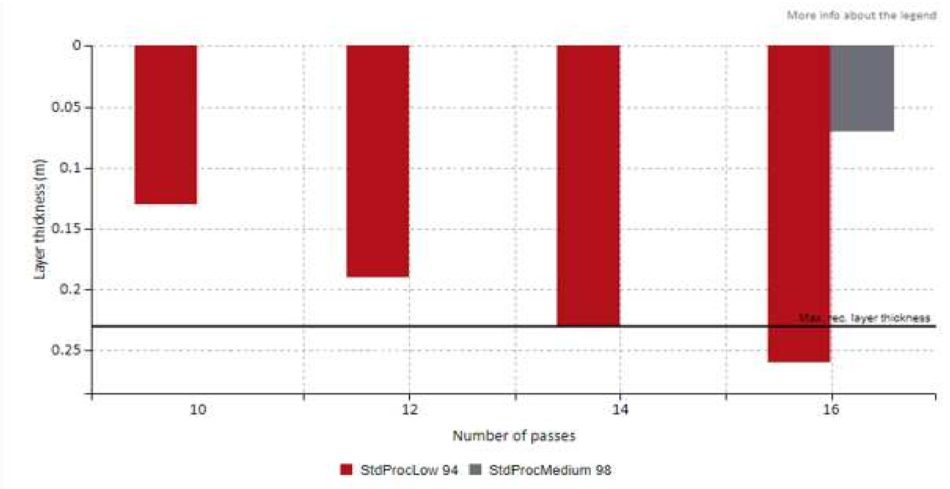
- Variables

SOIL COMPACTION DETAILS

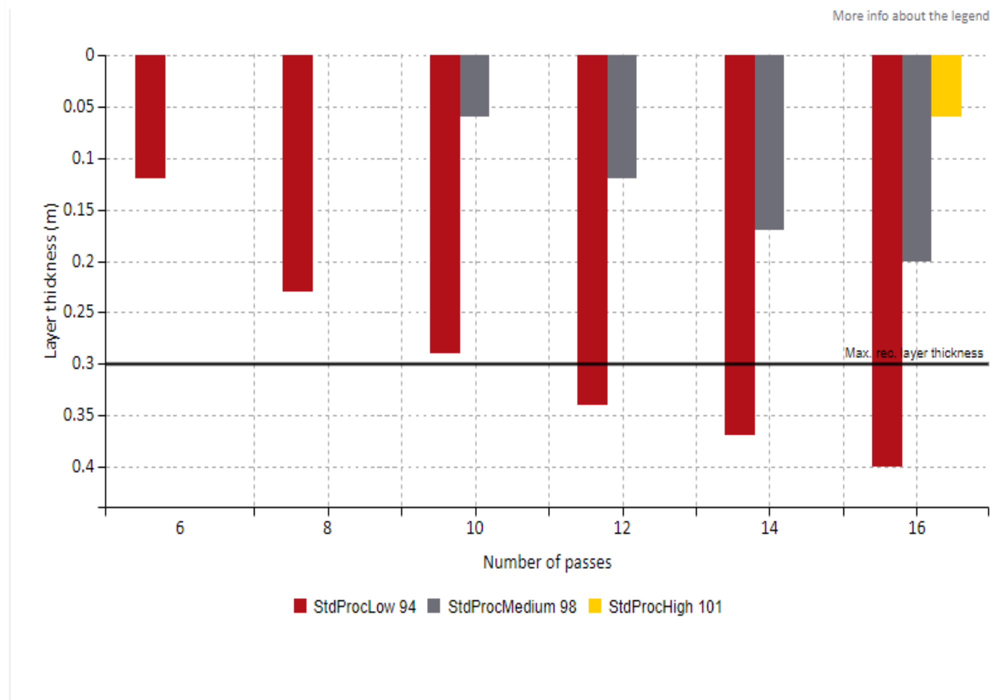


Capacity (m^3/h)		Number of passes						
		4	6	8	10	12	14	16
Thickness (m)	0.1	82	55	41	33	27	23	21
	0.2	164	110	82	66	55	47	41
	0.3	247	164	123	99	82	70	62
	0.4	329	219	164	132	110	94	82

Comparison; CA1300PD (Left) CA2500PD (Right)



CA1300 recommended Maximum material Thickness 225mm
CA2500 recommended Maximum material Thickness 300mm
CA1300 recommended number of passes (200mm Thickness) 12
CA2500 recommended number of passes (200mm Thickness) 8
CA1300 drum width 137cm
CA2500 drum width 123cm



Your Partner
on the Road Ahead