A RESEARCH WORK ON CEMENT STABILIZATION OF SOIL

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Introduction

Cement stabilization refers to the process of changing soil properties to improve strength and durability by adding cementitous material along with water.

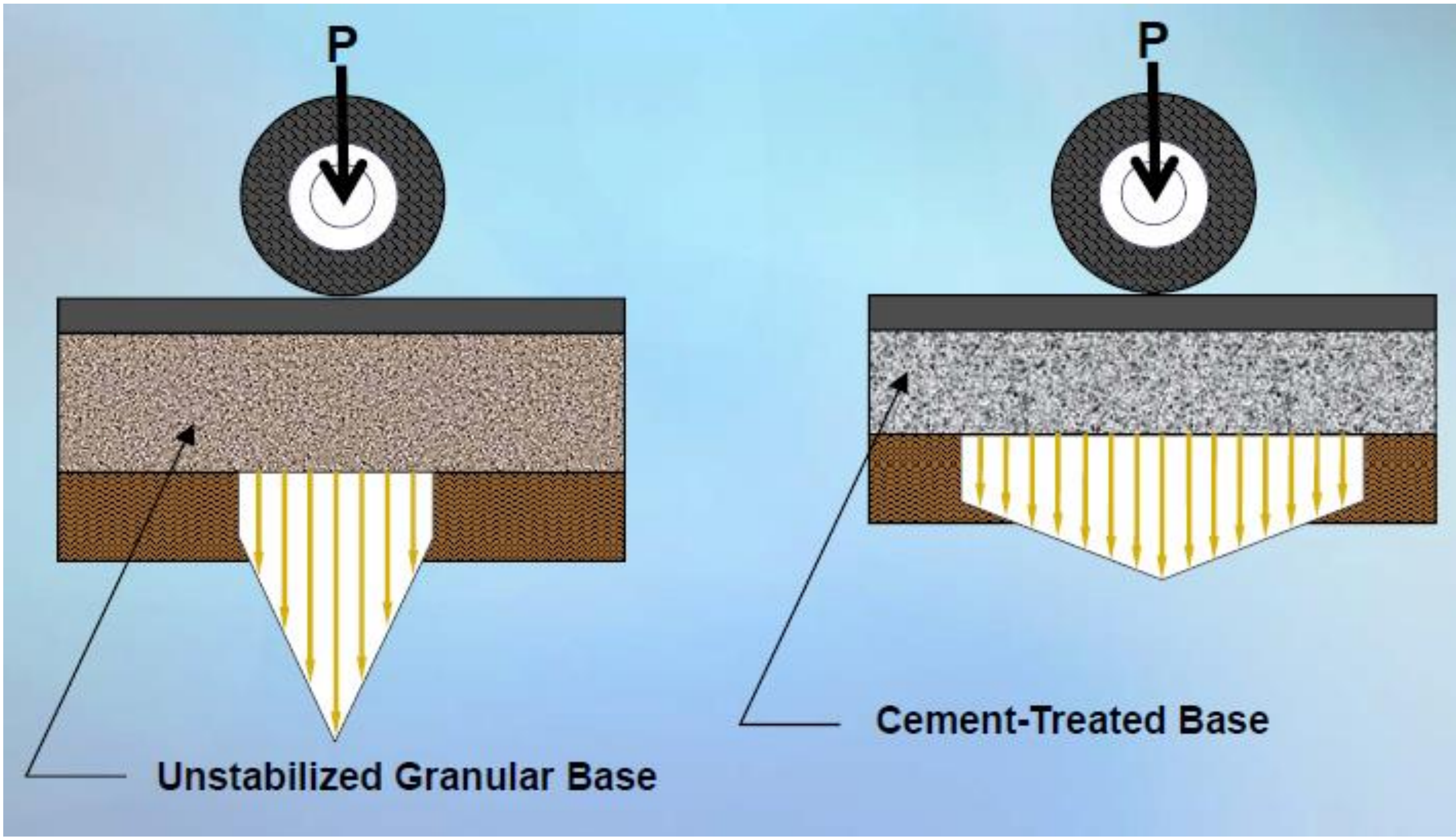
Cement stabilization is the type of chemical stabilization for the improvement of soils.

This process immediately improves the material's plasticity, compressibility and bearing capacity.

Cement Soil Stabilization …… Why ??

- Decreased base thickness compared to unbound aggregate base
- High stiffness prevents fatigue cracking and rutting of asphalt surface
- Economical pavement base (lesser thickness – High CBR)
- Increased durability, stiffness and bearing capacity
- Increased resistance to frost and weathering
- Increased impermeability
- Greater control of swelling
- Good performance in hot weather, with no deformation or rutting.

Load Distribution

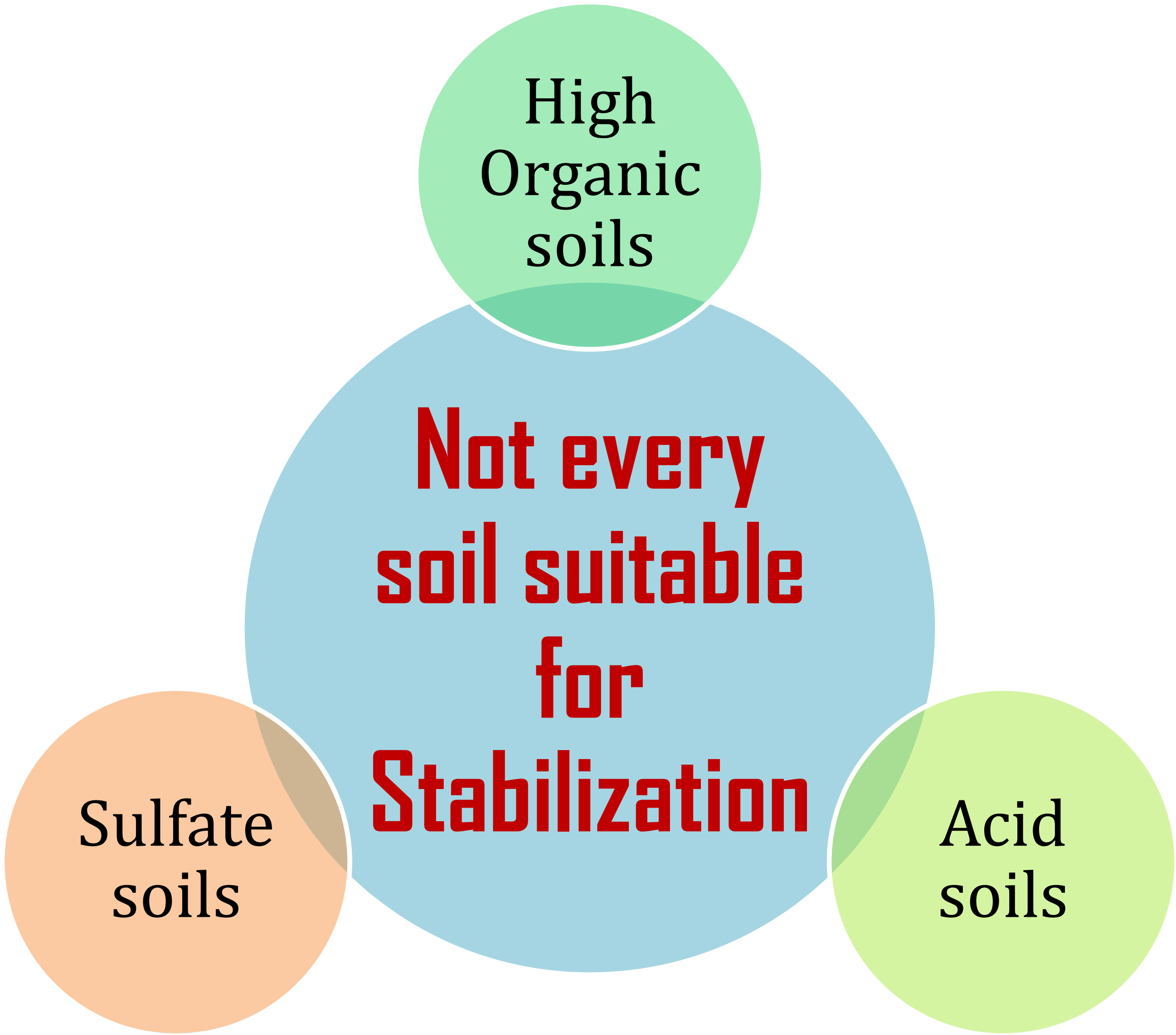


Cement Soil Stabilization …… Where ??

- Waterlogged site (rapid reduction of moisture content)
- Reclamation and remediation of contaminated land
- Airport runways, taxiways and aprons
- Highway pavement construction
- Foundations for floor slabs
- Car and lorry parks

Factors Affecting Soil Cement Stabilization

- Soil
- Cement
- Pulverization and Mixing
- Compaction
- Curing
- Additives


High Organic soils
Not every soil suitable for Stabilization
Sulfate soils
Acid soils

2nd Presenter

Cement Soil Stabilization …… Mix Design

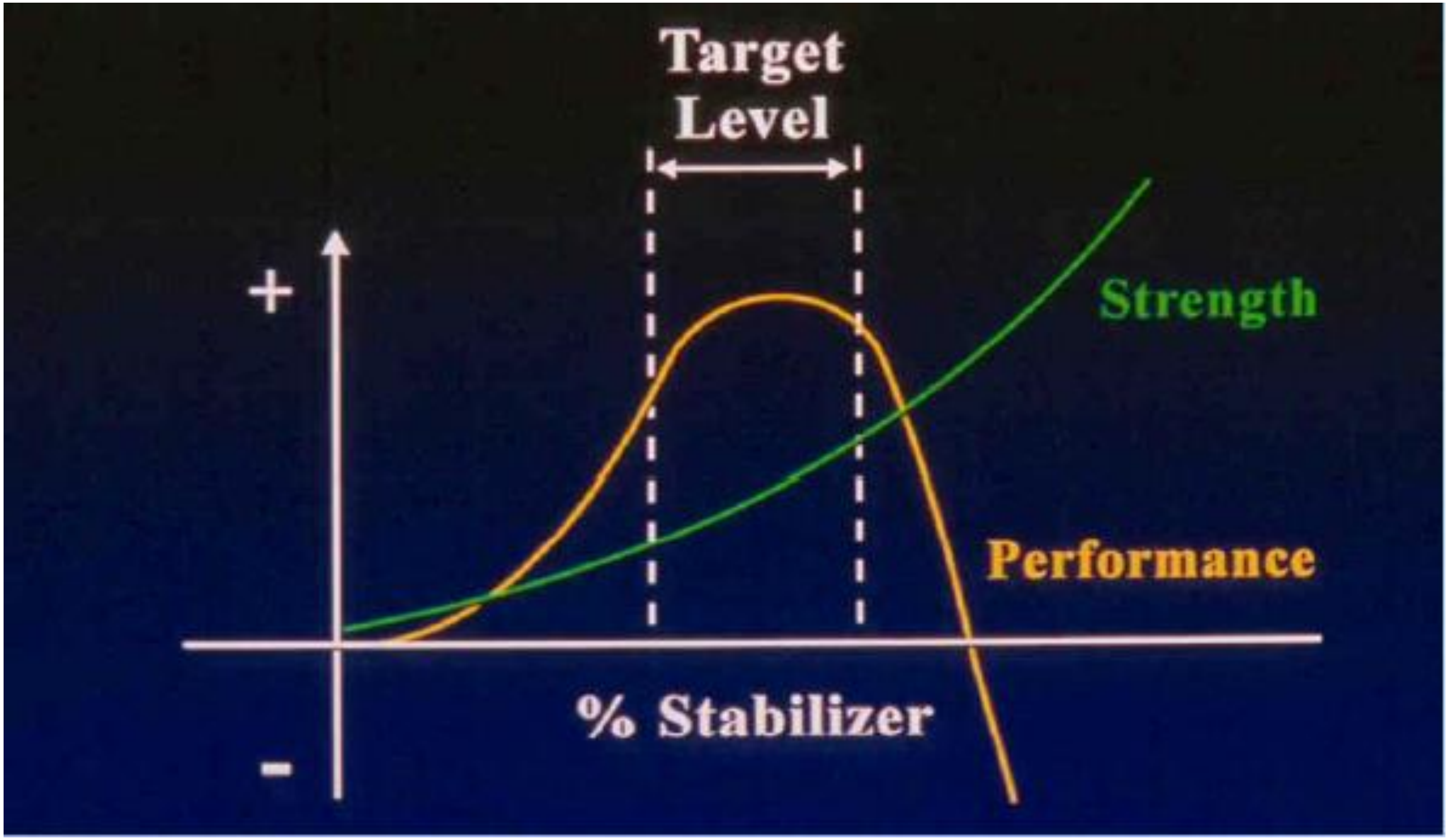
The criteria for cement percentage required for stabilization shall be as follows. The following methodology shall be used for quality control and soil-cement stabilization.

1. Perform the mechanical and physical property tests of the soils.

2. Select the Cement Content based on the following:

AASHTO Classification	Usual Cement Ranges for Stabilization (% by dry weight of soil)
A-1-a	3 – 5
A-1-b	5 – 8
A-2	5 – 9
A-3	7 – 10

Cement Soil Stabilization …… Mix Design



Mix Design Step 1
Determine Moisture Density Relationship

- Perform standard or modified Proctor test (ASTM D558 or ASTM D1557)
- Construct moisture-density curve
- Determine optimum moisture content and
- maximum dry density

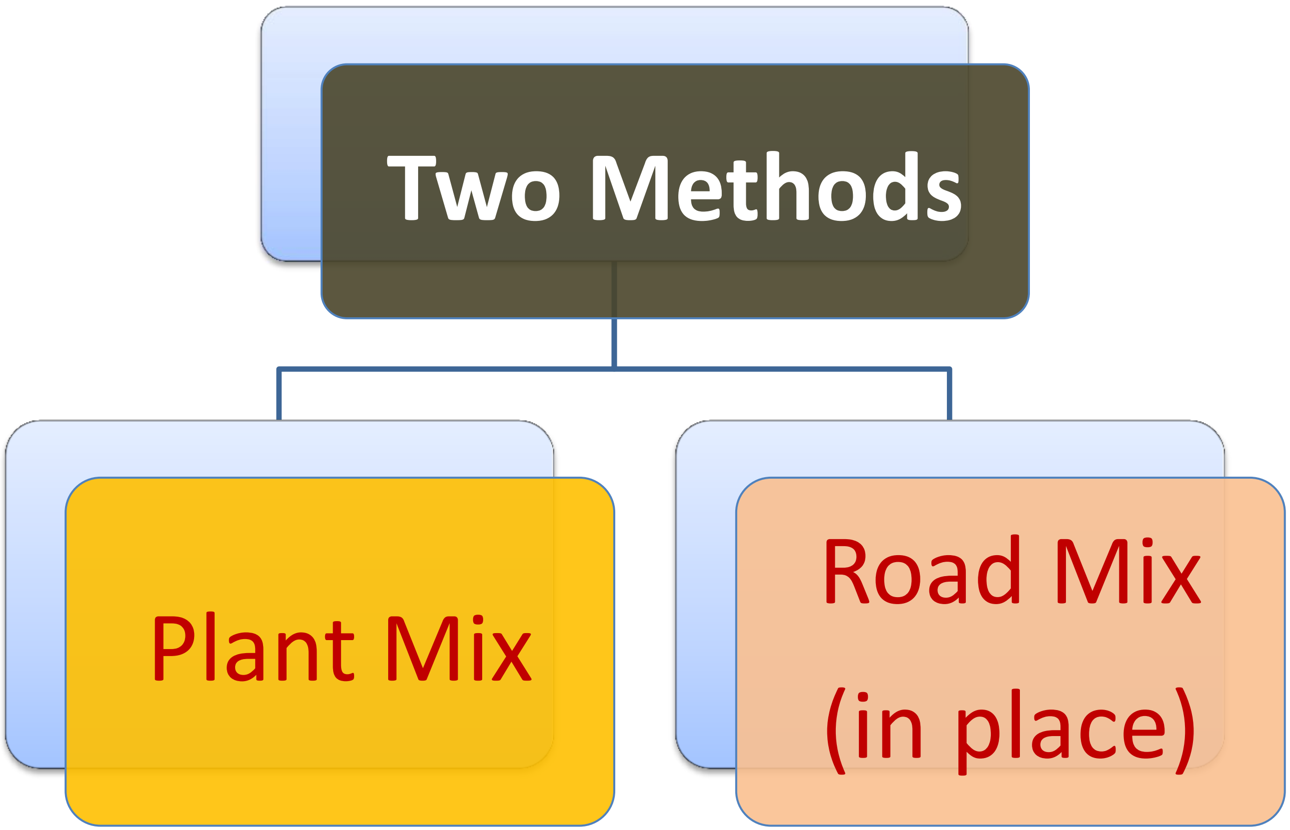
Mix Design Step 2
Mold specimens for compressive strength testing

- Select range of cement contents (e.g. 4%, 6% and 8% by dry weight of material)
- Use percent OMC from Step 1 and Mould two specimens per cement content (ASTM D559/560 or ASTM D1632)
- Perform compressive strength testing (ASTM D1633)
- Plot cement content versus compressive strength

Mix Design Step 3
Determine moisture-density relationship of target cement content

- Perform standard or modified Proctor test
- (ASTM D558 or ASTM D1557)
- Construct moisture-density curve
- Determine optimum moisture content and maximum dry density

Cement Soil Stabilization …… How ??



Plant Mix

High Production

Usually close or on-site

Mobilization cost

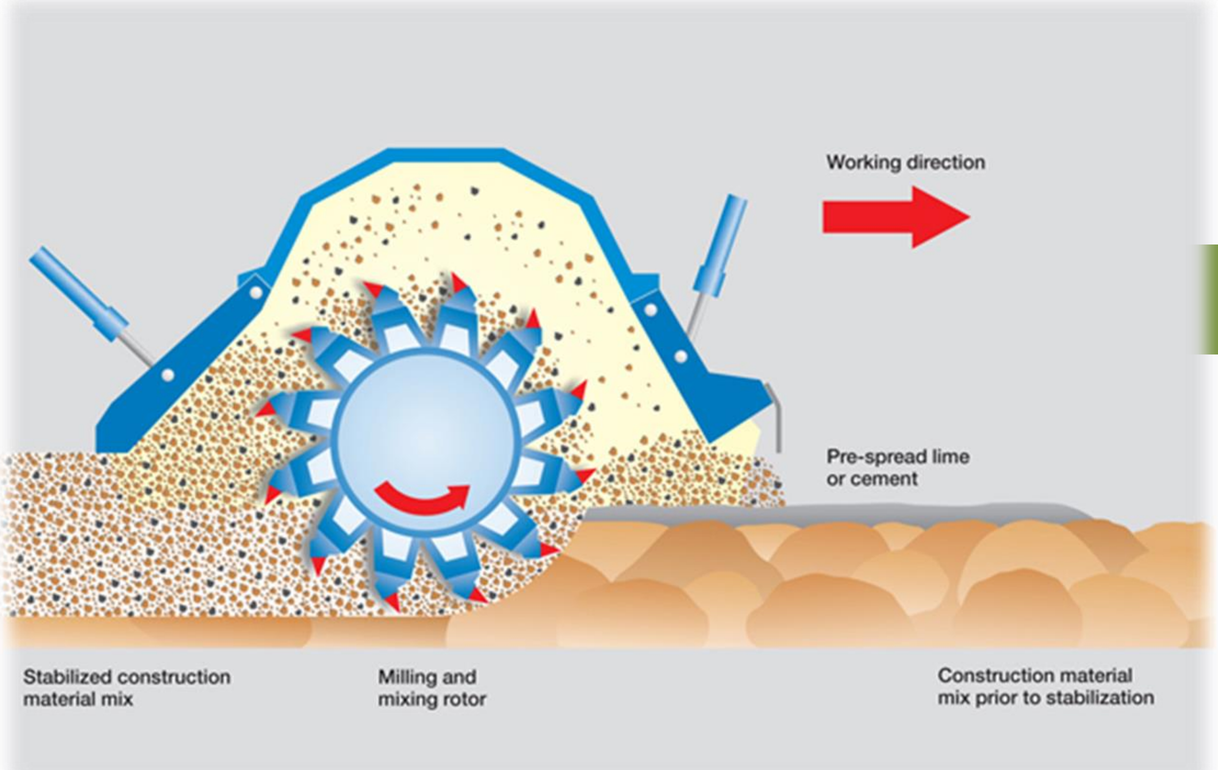
Road Mix

- In-situ or mixed in place materials
- Wider variety of materials
- Dry or slurry cement application method

Road Mix Method

Spreading Cement

Mixing



Grading

Compaction

Curing
(Water / Bituminous Material)

3rd Presenter

RESEARCH WORK

Research Work

Objectives of Research:

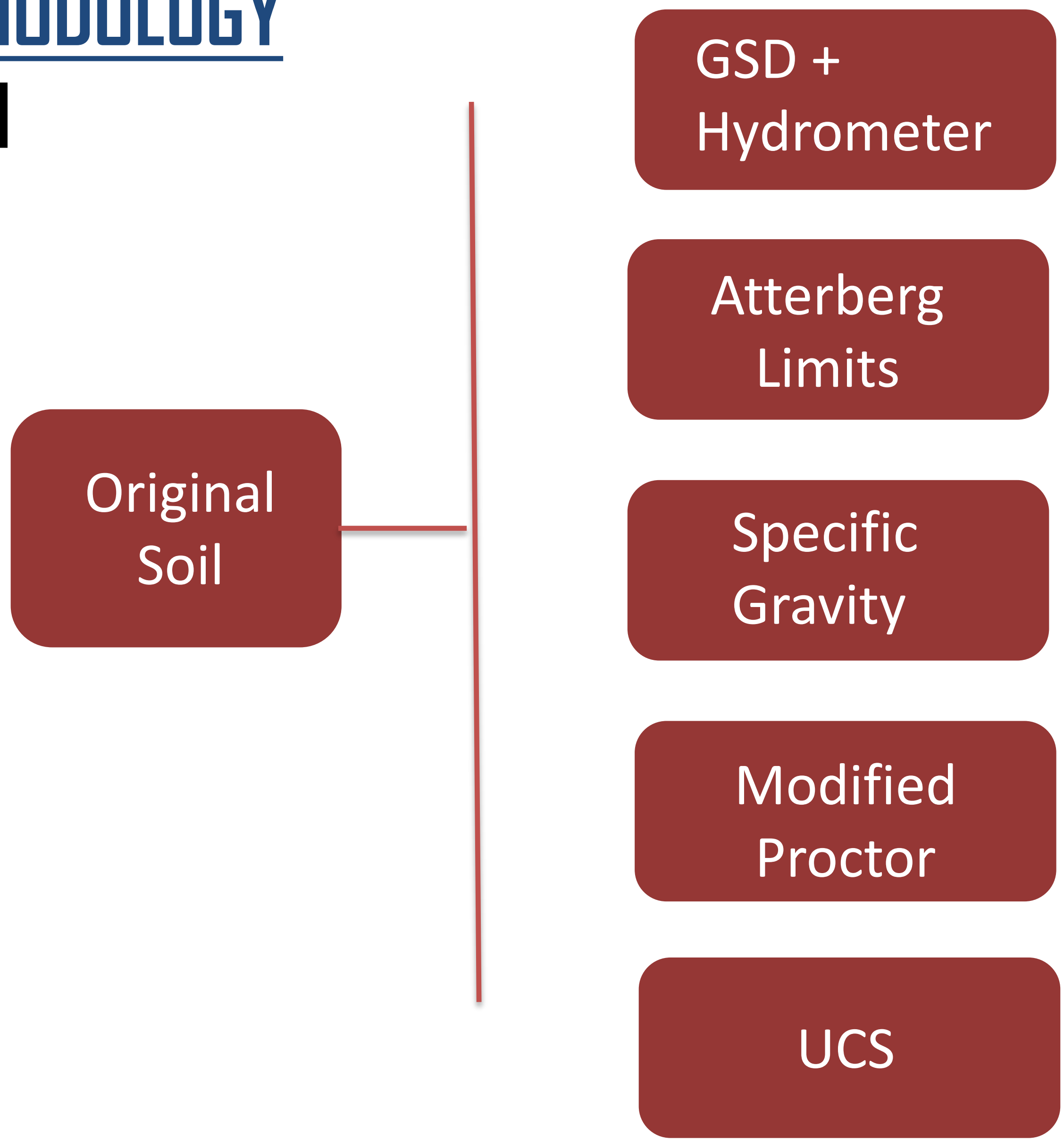
- To study the effect of cement on plasticity and UCS of soil.
- To determine the Optimum Cement Content for getting maximum gain in strength and resistance to swell potential.

Program of Work:

- Determining index properties and classifying the soil.
- Determining compaction characteristics and specific gravity.
- Effect of Cement on plasticity of soil.
- Effect of Cement on Unconfined Compressive Strength.
- Effect of Curing Time on Unconfined Compressive Strength.

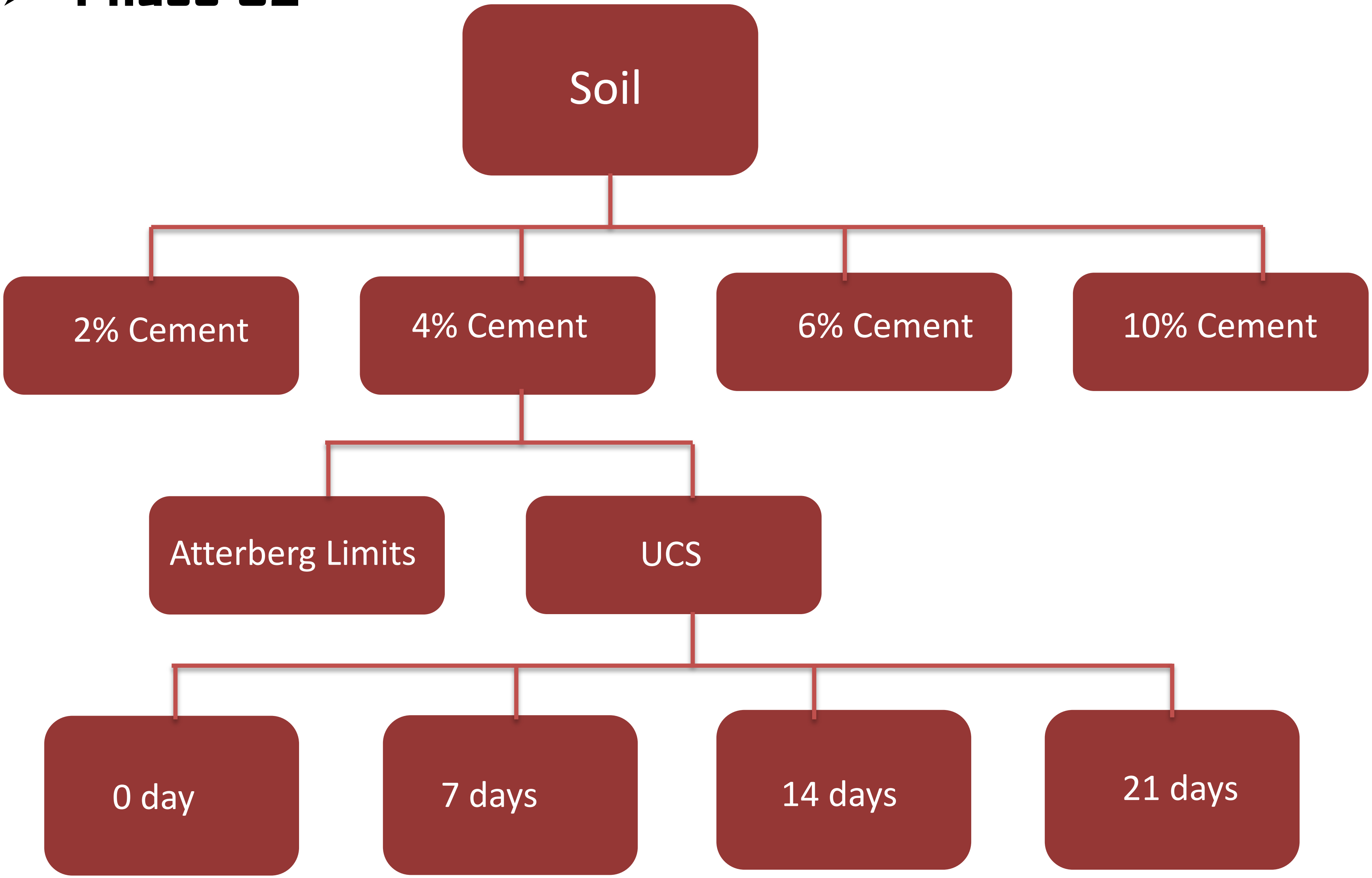
WORK METHODOLOGY

- Phase 01

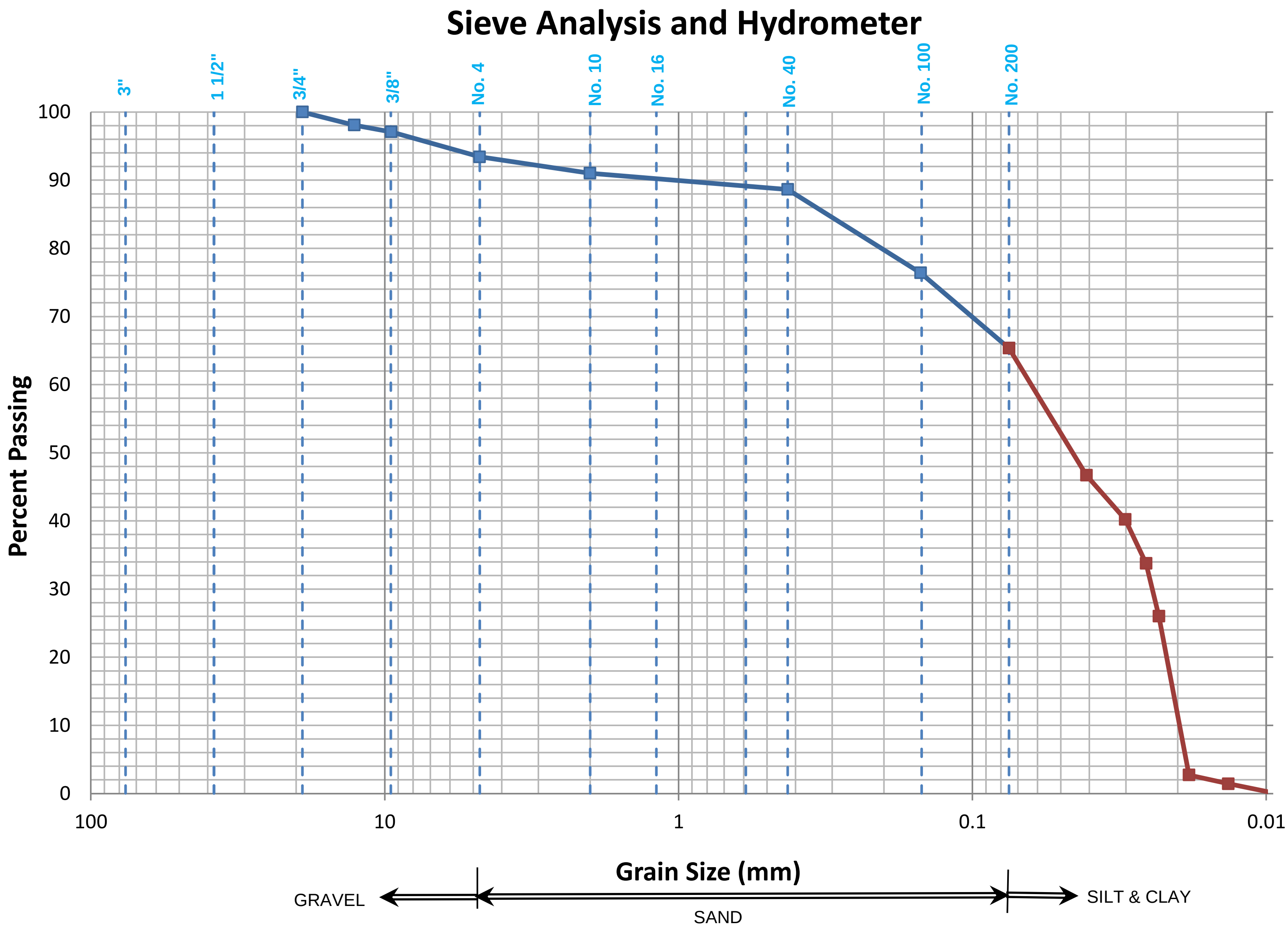


WORK METHODOLOGY

- Phase 02

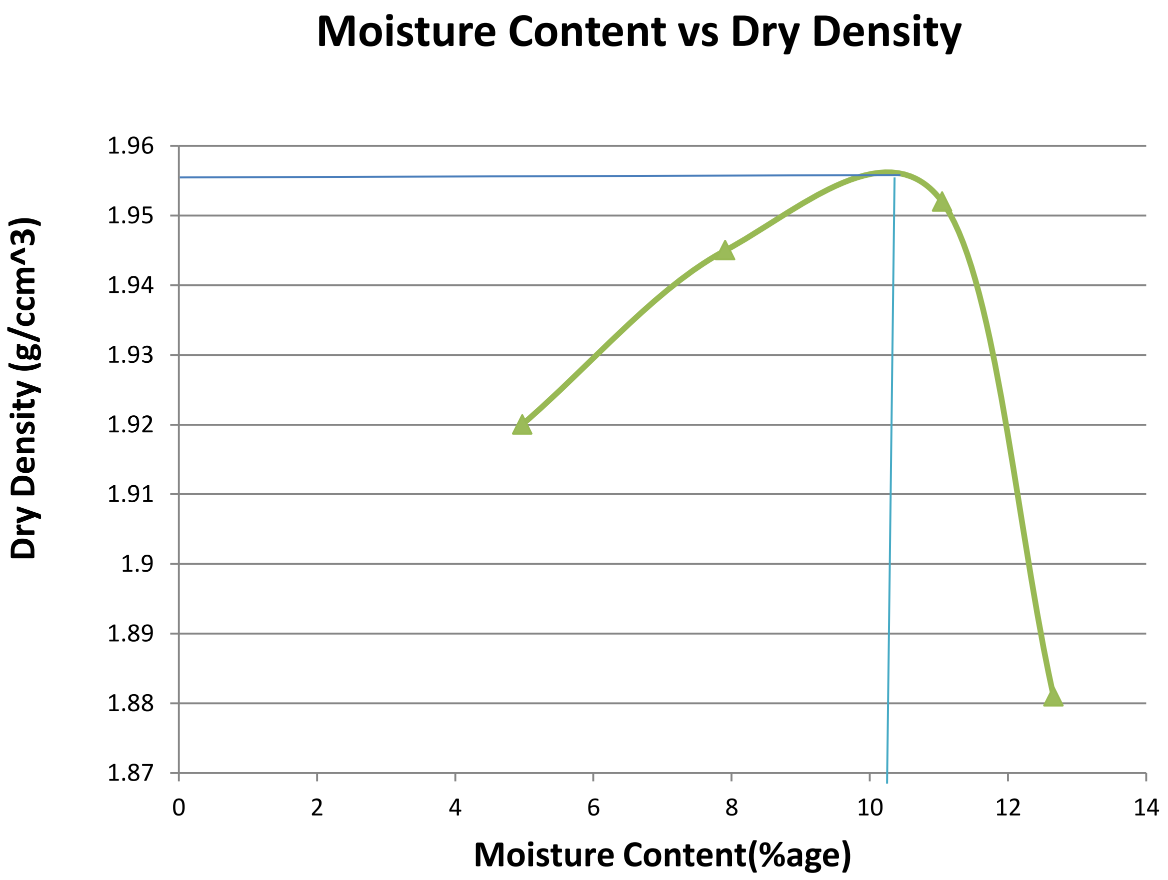


Grain Size Distribution

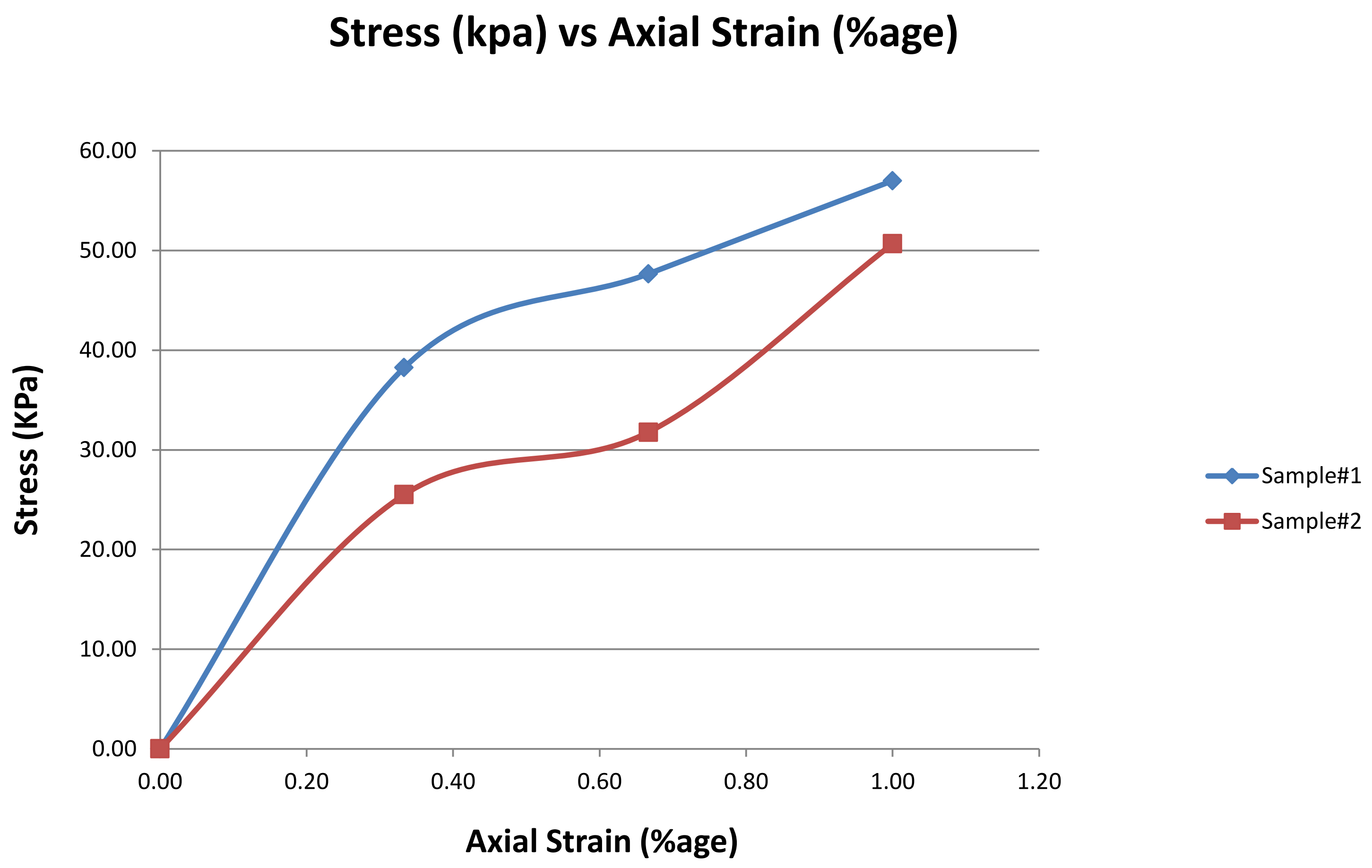


Compaction Curve

- O.M.C = 10 %
- Max. dry density = 19.5 g/cc



Unconfined Compression Test

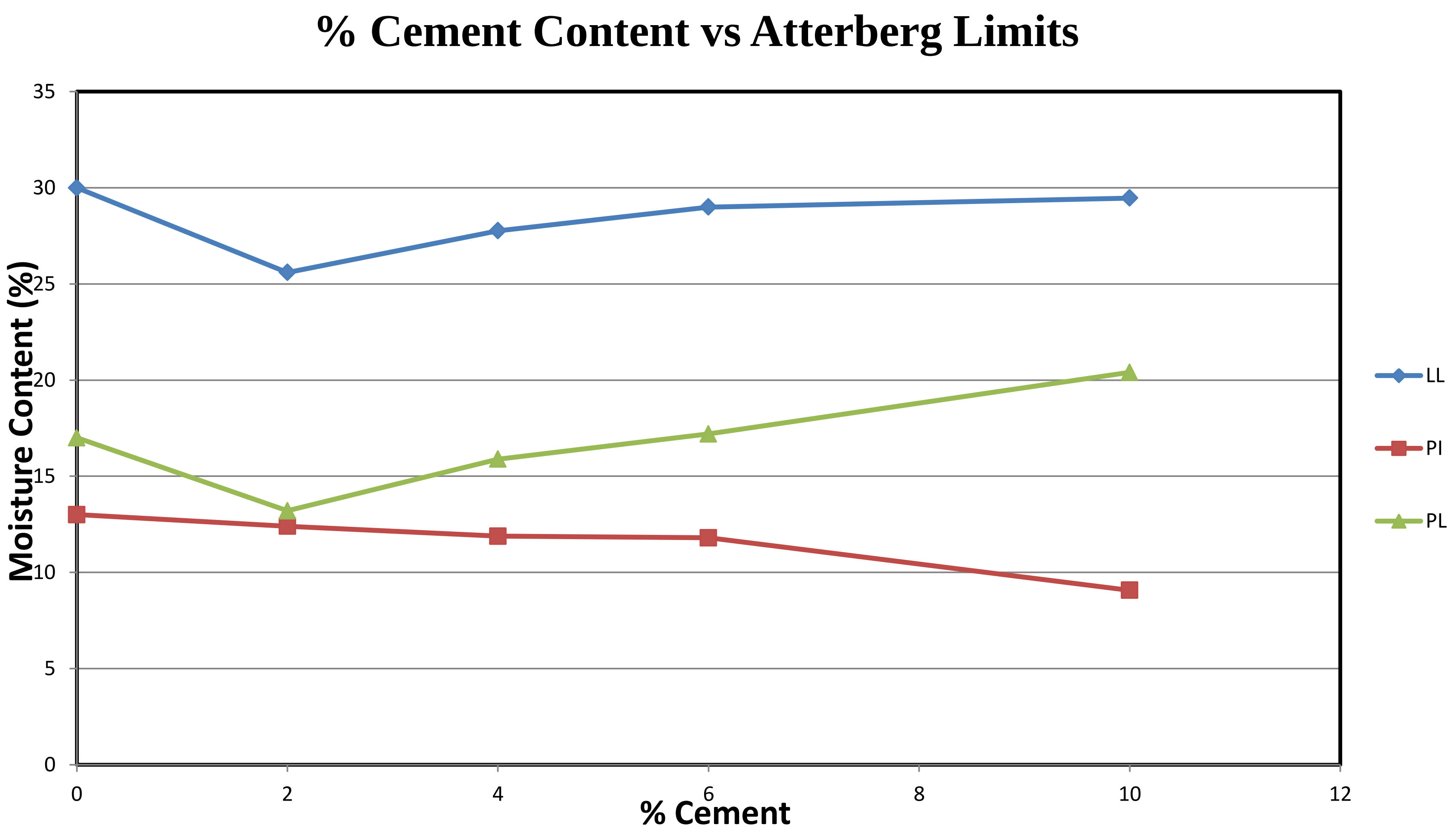


Index Properties of Original Soil

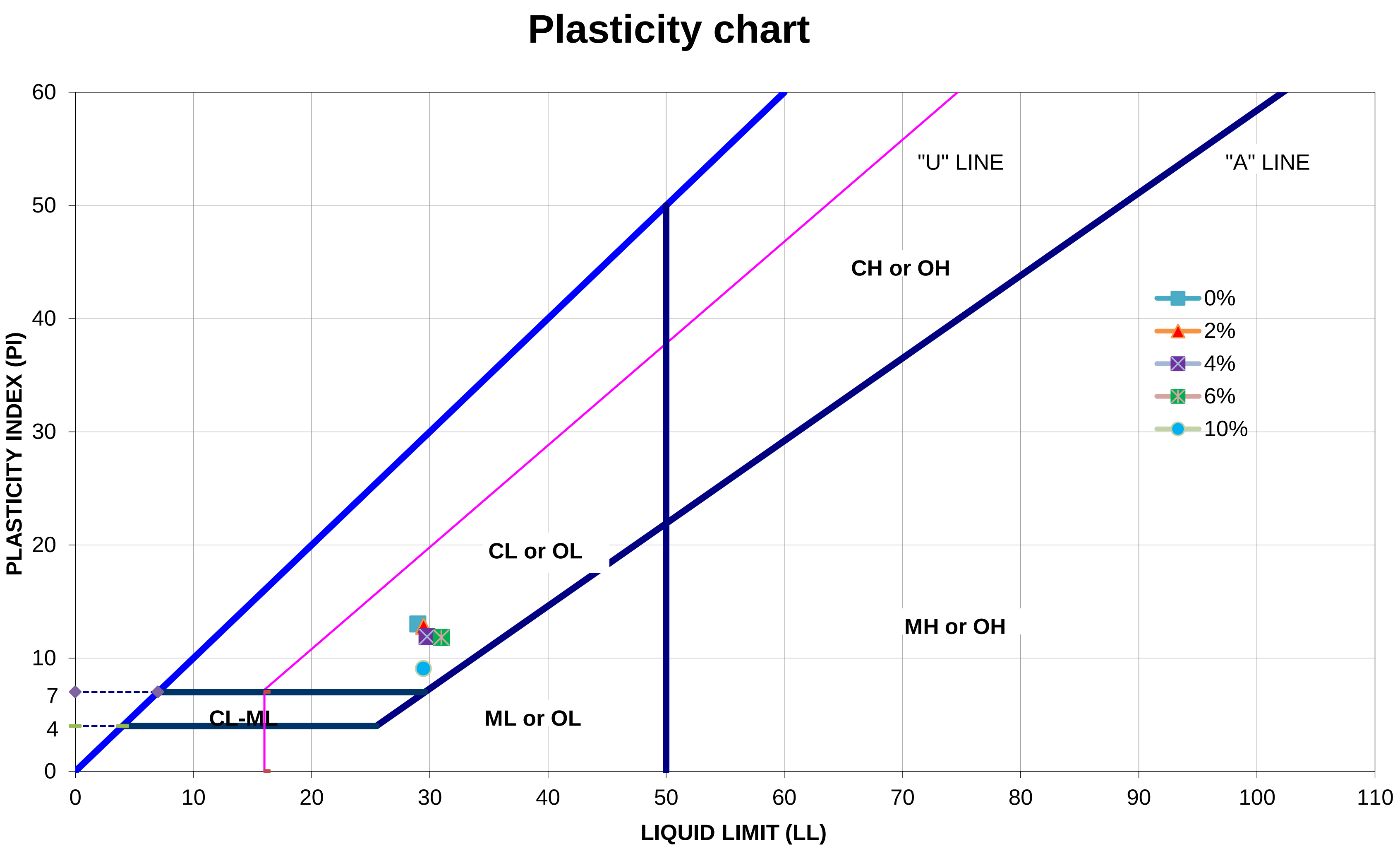
Gravel	7 %
Coarse Sand	2 %
Medium Sand	2 %
Fine Sand	23 %
Silt & Clay	65 %
Liquid Limit	30 %
Plastic Limit	17 %
Plasticity Index	13 %
Soil Type	CL-ML
Maximum Dry Density	1955 kg/m^3
OMC	10 %
UCS	55 kpa
Specific Gravity	2.63

4th Presenter

Effects of Cement on Atterberg Limits



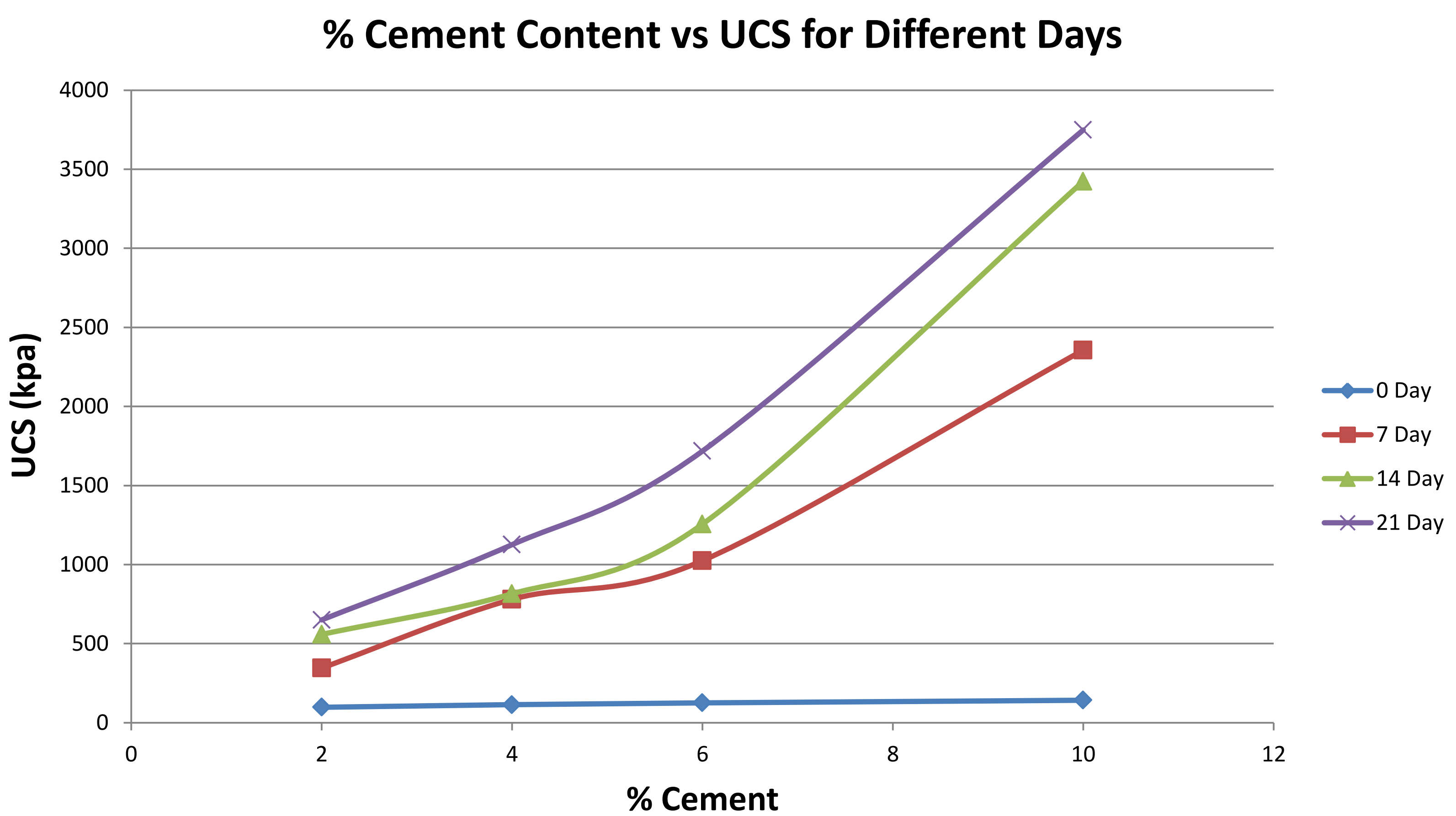
Plasticity chart showing the original and cement treated soil



Comments

- Plasticity Index of Soil is slightly increased with the increase in cement content.
- Hence potential for volume change/swelling is decreased.
- Maximum reduction in Plasticity Index is achieved with 10 % cement trial, although no more trials were performed due to time constraints.
- Great practical significance, especially for sub-grade soil improvement in road construction.

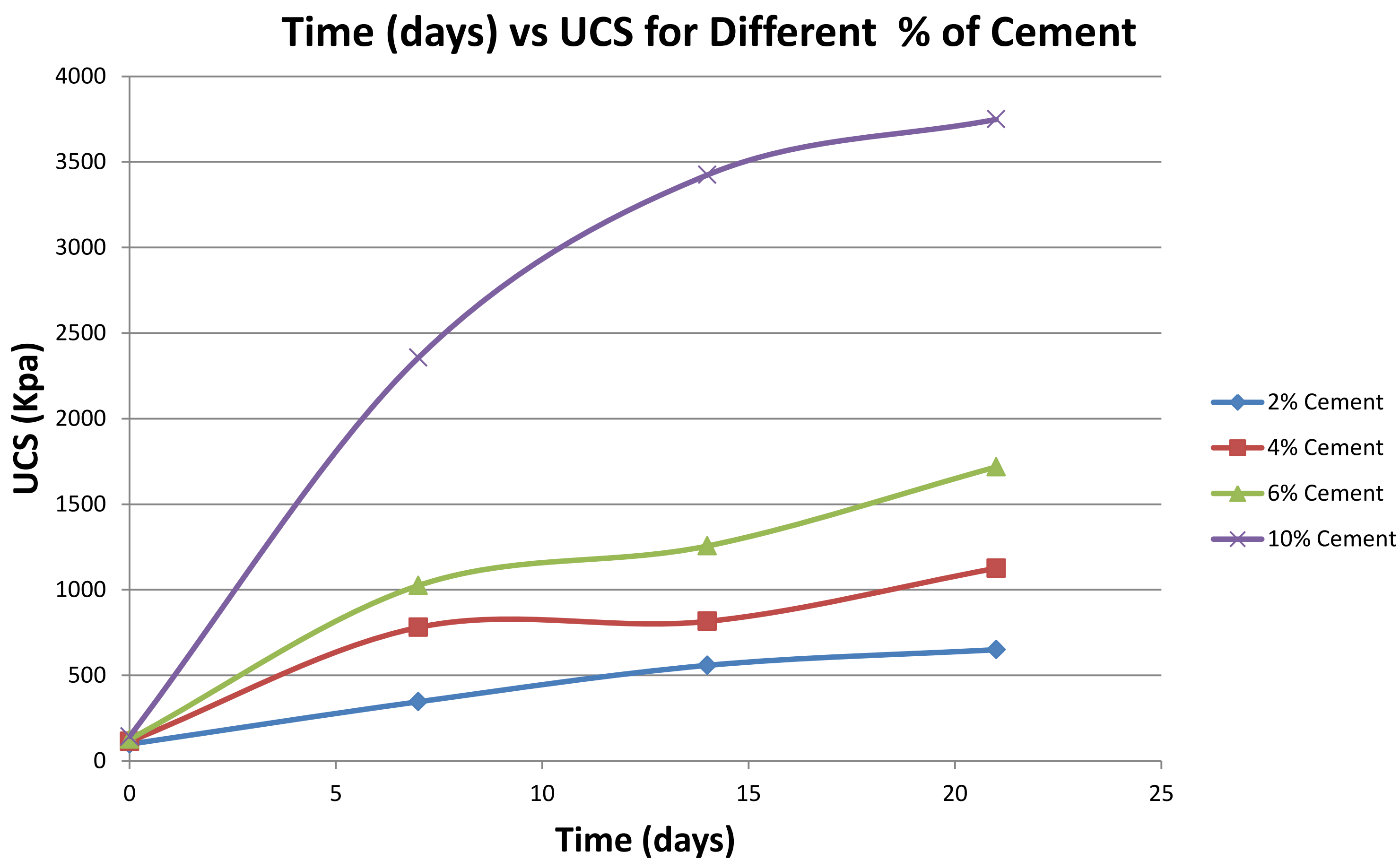
Effects of Cement on UCS



Comments

- The UCS of soil is increasing almost linearly with the increase of cement content.
- Although no increase in UCS is observed when samples were tested immediately (0 days UCS) after cement addition. Not enough time for setting of cement.
- Maximum gain in strength is achieved with 10% cement content.
- No further trials were tested due to time constraints.
- The possible mechanisms behind this remarkable strength gain have been suggested to be:
  - Either due to formation of strong nuclei by cement distributed throughout the soil mass.
  - Or due to formation of a skeleton of hydrated cement throughout the voids.
  - Nucleated structure at low cement contents might change to a skeleton structure at high cement contents.

Effects of Time & UCS with Cement Content



Comments

- Graph shows that the gradual increase of strength with the age of curing is in accordance with the established trends.
- Maximum strength is achieved for curing period of 21 days.
- Rapid increase in strength with curing time is observed for 10 percent cement content.
- Unconfined compressive strength of soil cement samples tended to develop rapidly in an early curing stage and the development of strength tended to slow down afterwards.

Conclusions and Recommendations

Based on the results obtained from unconfined compression tests carried out on soil-cement samples prepared with different conditions, the following can be appropriate;

1. The given soil sample had inadequate strength, and addition of cement will increase the strength and bearing capacity if to be used in construction.
2. Soil-cement samples with higher cement content showed more brittle failures.
3. The cement content has more influence on unconfined compressive strength than curing time.
4. To conduct test on 0 days with % of cement it should be tested at least after the initial setting time of cement.

Conclusions and Recommendations

5. According to test results obtained, addition of 10% of cement should be added for this particular soil to achieve maximum gain in strength and resistance to water softening.

6. Although more trials with increased cement content are recommended to attain the optimum cement content which could not be done due to time limitations. Too high a cement content can cause problems due to shrinkage and thus this must be taken into account while selecting the cement content.

References

- SOIL IMPROVEMENT & STABILISATION (European Concrete Paving Association).
- http://civilengineersforum.com/soil-cement-stabilization/
- Zeena Tariq Jaleel Eng. & Tech. Journal, Vol.29, No.6, 2011 “Effect of Admixtures on the CBR-Value of Sub-base Soil.
- Notes on “Soil Improvement Techniques” by Sir Sardar Babar.
- Thesis by Hafiz Muhammad Anas, Waseem Waheed and Danish Farooq on “Stabilization of Problematic Soil using Cement as an Admixture” UET Taxila (2008)