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Highway & Traffic Engineering

INTRODUCTION TO ROAD TECHNOLOGY AND CONSTRUCTIONS OF PAVEMENT BASES

by

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Chapter Description

- **Aims**
 - Understand the history of road technology, important criteria in road design and most basic layers of road in a construction of road.
- **Expected Outcomes**
 - Students should be able to understand evolution of road technology
 - Students should be able to identify the most crucial aspects in road construction
 - Students will understand the different layers on road.
- **References**
 - Highway Engineering, Paul H. Wright / Karen K. Dixon
 - Images are taken from other related websites



Roads History

- Road was first built to cross swamp and mountain, not in towns and villages
- Roads was built to transports human needs, good and travelling purpose.
- The world's oldest known paved road was constructed in Egypt some time between 2600 and 2200 BC.

Jalan TAR, KL – 1980an



Why we need road?

History of Roman Roads

- Roman is the first to built straight & strong stone Roman roads throughout Europe and North Africa.
- They used road mostly to commute from one place to another in support of its military campaigns
- <http://www.history.com/topics/ancient-history/ancient-rome/videos/mankind-the-story-of-all-of-us-roman-roads>

Development of Road Technology – Roman Roads



Images from http://www.romanobritain.org/12_innovations/inv_roads.htm

Roman road

- Used by horses, chariot and wagon pulled by animals.
- The whole sets of roads were consisted of several layers
- The roads were made up with stone blocks put closed together.

Metcalf and Telford Roads

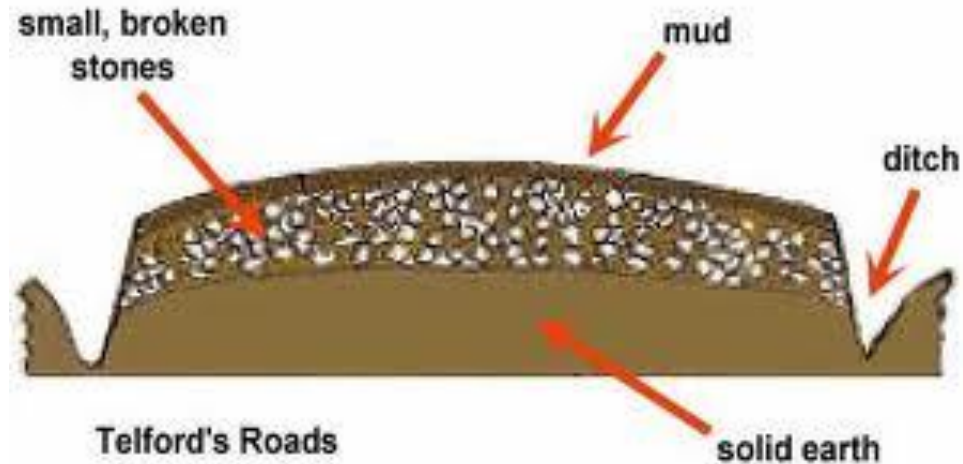
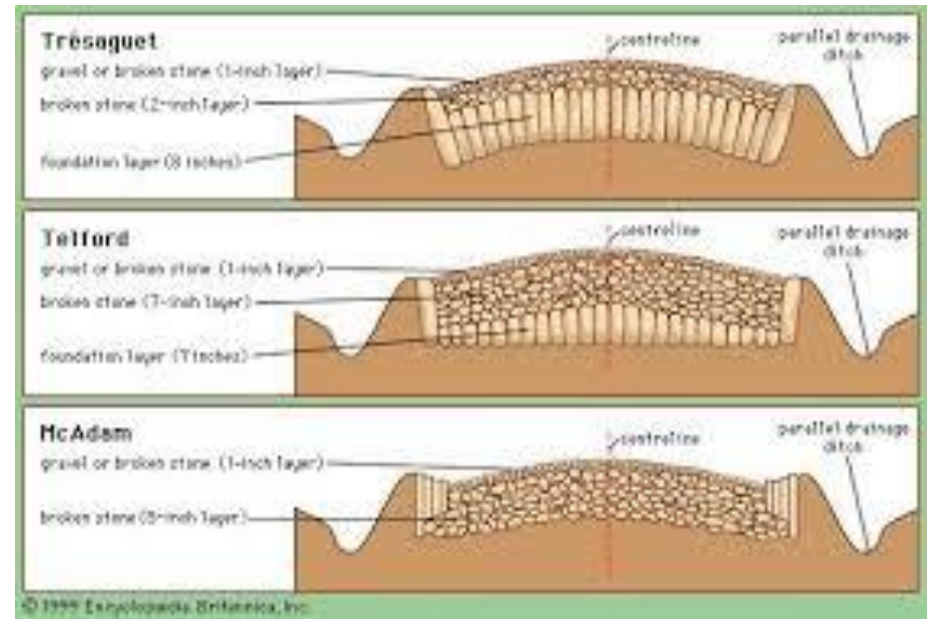


Image from <http://www.saburchill.com/history/chapters/IR/024.html>

Metcalf and Telford shared almost the same important elements of road constructions:

- Surface water / drainage
- Good foundation system.

John Macadam's Road

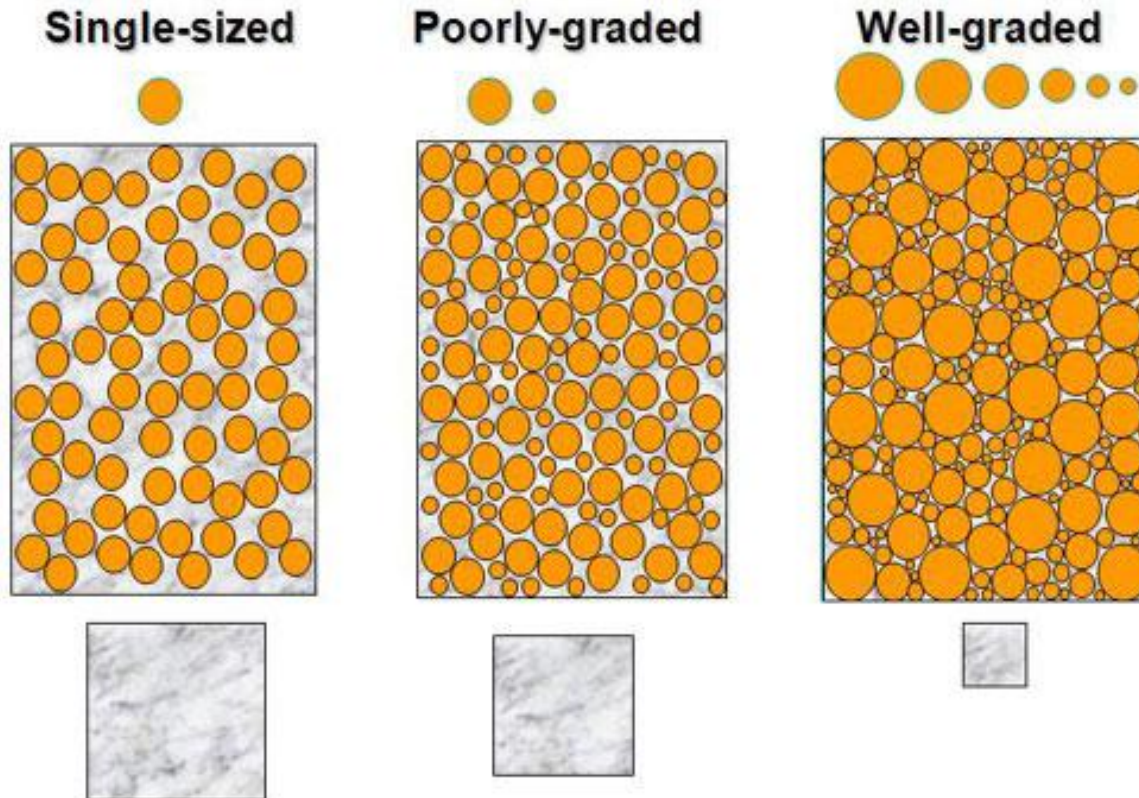


Images from <https://www.britannica.com/biography/John-Loudon-McAdam>

Macadam Roads

- Emphasis on the **grading** and **drainage** of the subgrade and **crowning** of the road surface for rain water removal.
- Water-bound macadam roads
 - Aggregate are bound together by stone dust and water applied during constructions
- Bituminous macadam roads:
 - Aggregate are bonded together with bituminous material.

Aggregate Grading



Images from <https://www.quora.com/What-is-the-practical-use-of-controlling-the-grading-of-concrete-aggregate>

Drainage of Roads

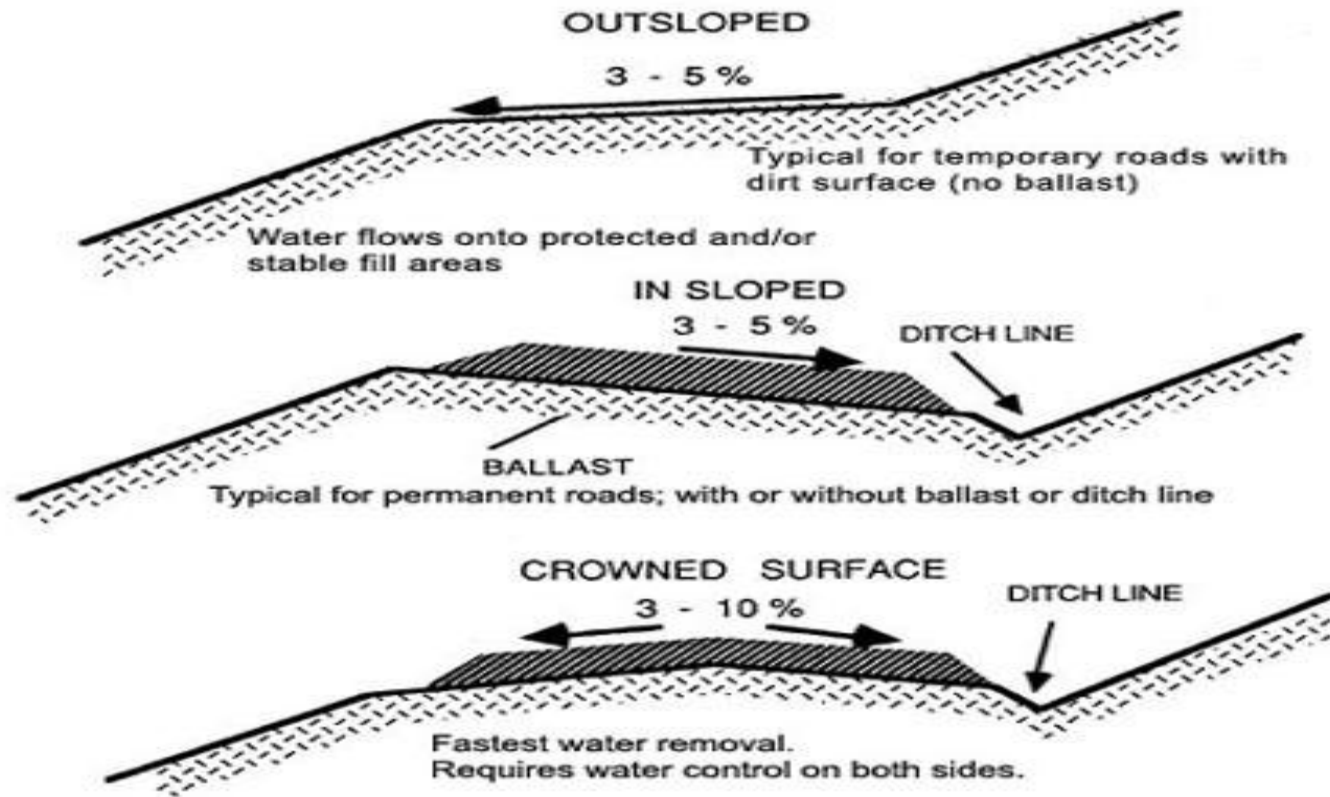
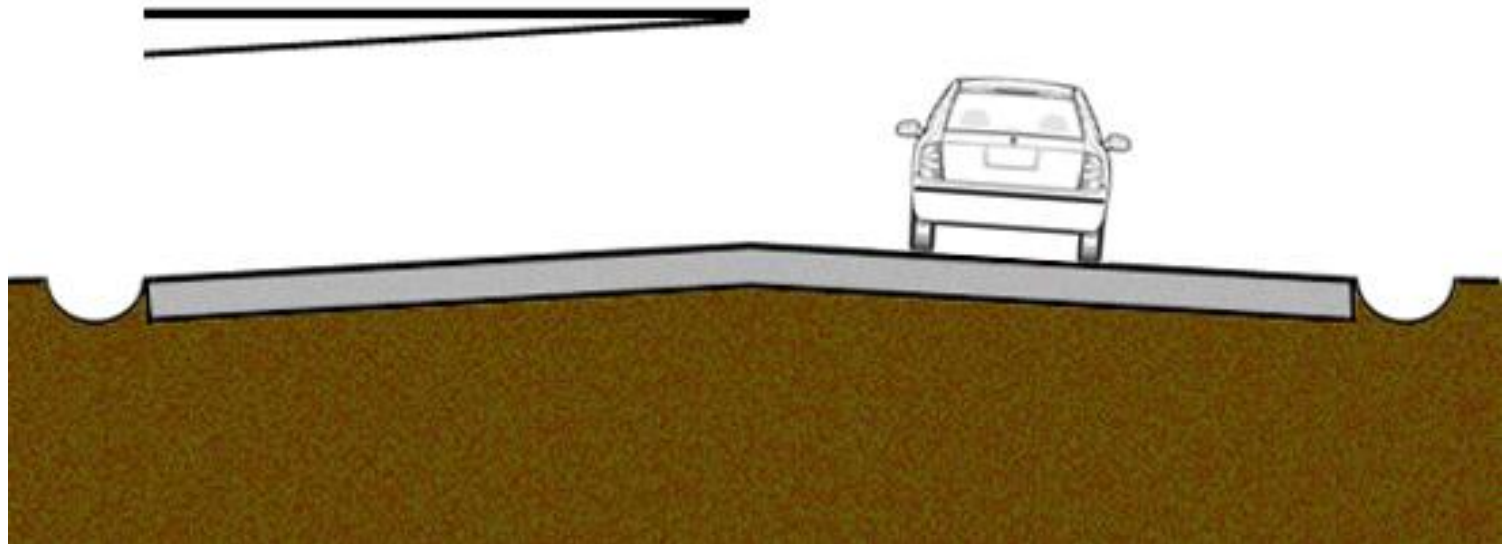


Image by : FAO Corporate Documents Repository, Forestry Department

Crowning of Roads

road crown
about 1/2" per foot
allows for drainage

agcoauto.com



What is Pavements?

- The road pavement is the actual surface on which the vehicles will travel.
- It's purpose is to provide friction for the vehicles and to transfer normal stresses to the underlying soils.
- Pavement can be categorized into 2 most common types:
 - Flexible Pavement
 - Rigid Pavement

Pavement Surface and Bases



What is sub-grade, sub-base and base?



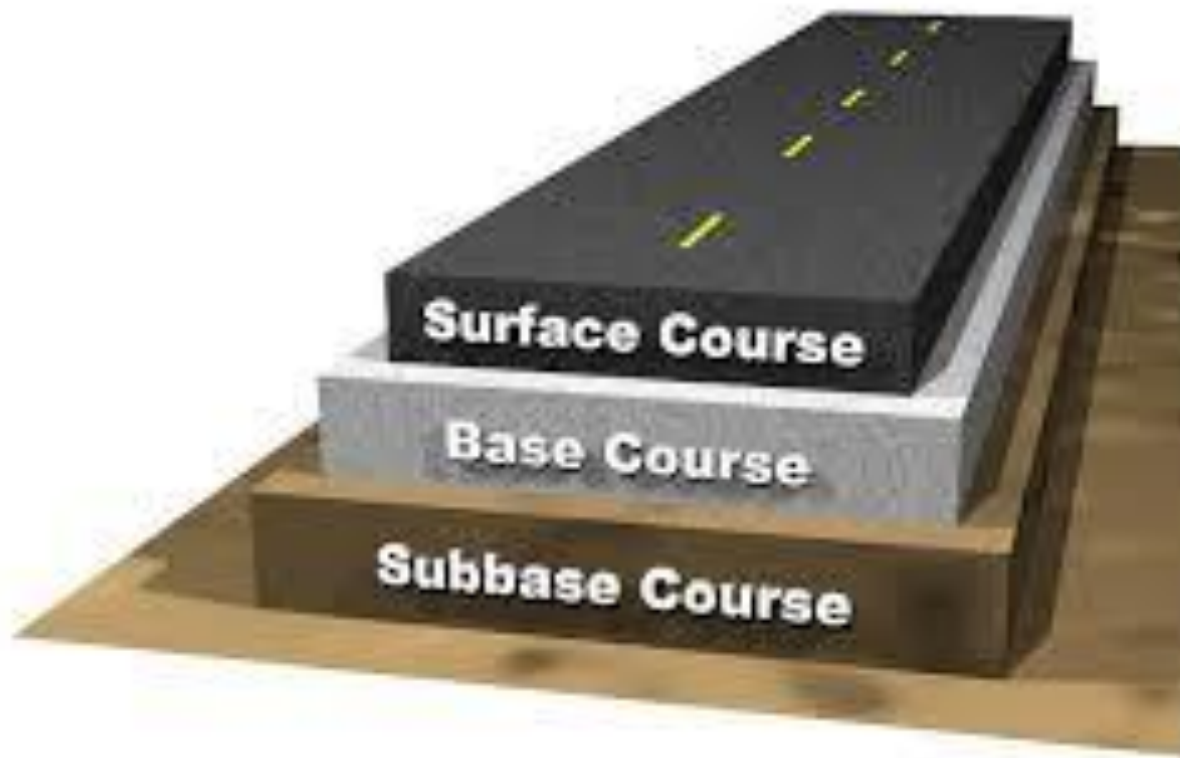
Surface Layer

Base

Sub-base

Subgrade (Natural and
Compacted)

Pavement Layers



Definition Of Sub-Grade

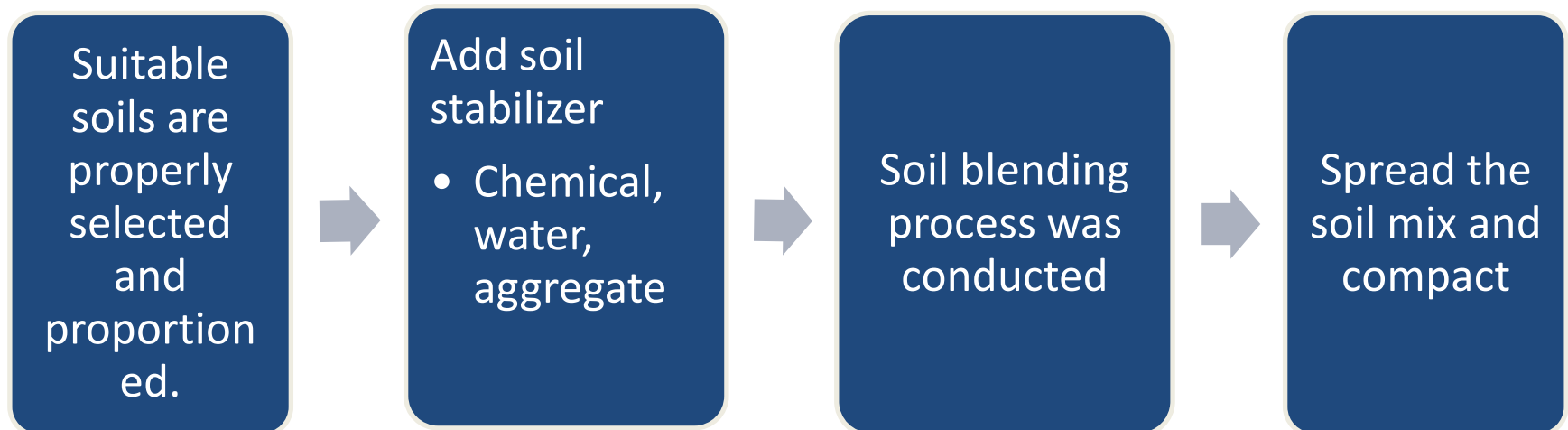
- In highway engineering, **subgrade** is the **native** material which the pavement structure is placed.
- Sub-grade consists of natural ground which coming from:-
 - Cut Process
 - Fill Process } Compacted
- Also been called as FORMATION LEVEL
- The cut and fill quantity must be similar to avoid wastage.

Subgrade Preparation



An area between ground level and subgrade / formation level need to scrap off due to the instability of the soil. This EARTHWORK procedure consist of clearing, grubbing, cut and fill that includes excavations of soils.

Subgrade Construction Process



Soil Blending Process



Existing road

Why the level of existing roads and road under construction is different?

Road under construction

Subgrade Physical Properties

- California Bearing Ratio
 - CBR is basically a measure of strength and swelling potential of a soil by comparing the bearing capacity of a material with that of a well-graded crushed stone (thus, a high quality crushed stone material should have a CBR @ 100%).
- *Resistance value (R-Value).*
 - A test that expresses a material's resistance to **deformation** as a function of the ratio of transmitted **lateral pressure** to applied **vertical pressure**.

Sub-Grade Treatment / Improvements

- Treatment of sub-grade includes :
 - Excavation and replacement of organic material with high quality materials.
 - Displacement of the organic deposits using surcharge (additional base layer).
 - Use of [geotextile](#) to separate base material from the sub-grade and to reinforce sub-grade strength.

Laying of Geotextile



Base and Sub-Base Courses

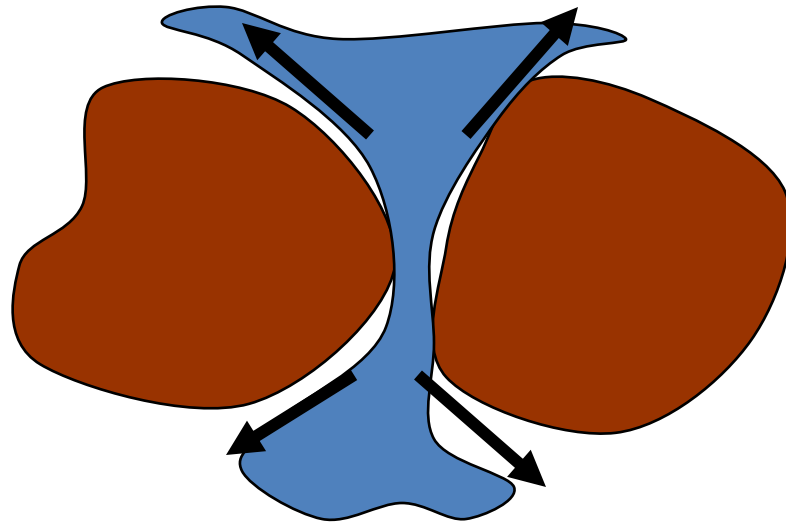
- Base courses composed of either one of these :
 - Solely granular materials (aggregates)
 - Soils / Sands
 - Granular materials stabilized by an additive.
- Granular may contains aggregate from sand, deposits from quarry, recycled concrete pavement, slag or other material.

Construction of Sub Base



- Base course must have an ability to distributes loads. This function are mainly taken by:-
 - The depth of the base course (main factor).
 - Materials quality.
- Base course must not failed in terms of shear failure and rutting.
- The strength is maintained by allowing water drainage to the sides of pavement structures.
- If sub-base full with water, frictions between aggregate were less.

Water Cohesion between Aggregate



Sub-base must be free-draining so that water is readily removed. If too much of fines, the base becomes saturated (with water), high stressed may be created by water that fills in the pores space. Resulting to a less frictional strength between particles (aggregate).

Sub-base and Base Drainage

- Drainage is important especially in high-volume multilane highways.
- Waters enter base through cracks and joints in surface, infiltration or through ground water.
- If bases becomes saturated, it will lose a load carrying capacity.

Examples

Explain on the effect of water cohesion to the strength of the aggregate?

Solution:

Water cohesion will pull the aggregate away from each other hence the load cannot be properly distributed to the lower layer. This situation will decrease the strength of the aggregates in overall.

Conclusion of The Chapter

- **Conclusion #1**
 - Grading, drainage of the subgrade and crowning are the most important factors in road design.
- **Conclusion #2**
 - Road pavement is consists of 4 different layer known as subgrade, sub base, base and surface course.
- **Conclusion #3**
 - Subgrade can be treated by using 2 most common methods i.e. either by soil improvement or geotextile.
- **Conclusions #4**
 - The ability of base course to distributes loads are taken by the depth of the base course and materials quality.
 - Water is the main factor of failure for sub base.

Author Information

Other relevant information (if any)

#author may apply your own creativity and innovation where it is appropriate