CHEMICAL STABILIZATION
PAVEMENT MOISTURE

CHEMICALLY STABILIZED PAVEMENT SECTIONS AS MOISTURE BARRIER

Pavement systems become inherently unstable when water is introduced to the system. When water is introduced pavement systems change and these changing conditions create variable and permanent reaction. Changes in the moisture content within a pavement system are the root cause of most pavement damage. In all regions, high moisture contents weaken the pavement's structural system from damage due to pore water. In cold regions, the effects of freezing and thawing of water in pavements systems are severe and cause rapid pavement deterioration. In regions plagued with moisture sensitive soils, the change in moisture content causes dramatic weakening, or expansion and contraction, causing additional pavement damage within the structural layers. Variable loading of saturated sections creates pumping action within the pavement aggregate layer causing migration of fine particles from the un-bound aggregate matrix.

Previous research indicates that in most roads, the primary source of water in upper pavement sections is from precipitation that has infiltrated through the pavement surface. A solution to the related damage would be to place a moisture collection system within the pavement layers to drain water from the pavement. However, drainage systems are often ineffective long-term because of clogging of the system from fine particle migration.

Pavement problems related to drying, or changes in moisture content, have traditionally been addressed by removing the moisture sensitive soils or again, by controlling excessive moisture through drainage. These methods for mitigation are expensive or have had limited success, and thus are often not considered effective, long-term solutions. The use of moisture barriers placed below, around, or within the pavement structure, may be effective in maintaining stability within moisture sensitive soils by keeping them at constant moisture content, but again are very expensive systems.

Stable Chemically Treated Base Undermined by Erosion

The use of chemical stabilization in water resource applications is very well documented. The main function of this application is to reduce the permeability, while maintaining strength during wet/dry and freeze/thaw cycles throughout the chemically treated section. In pavement structures the goal is essentially the same, to effectively limit the moisture in order to reduce moisture related pavement damage and to maintain the design strength when the section becomes fully saturated over time.

DRAINABILITY OF PAVEMENT LAYERS

Although the benefits of well-drained pavements have been clearly shown, practitioners still hesitate to use base courses that have a limited amount of fines because of concerns regarding lack of stability and migration of fine particles. While a well-graded base may be the easiest to work with from a construction standpoint, the strength or modulus and the permeability of these layers are lower than more free-draining aggregate that have limited amounts of fines. In the pursuit of a more free-draining aggregate base, some of the stability problems have been overcome by the addition of cement to the base.

Although, cementitious permeable bases are costlier solutions (especially for low- to medium-volume roadways) the long-term serviceability of these sections has been called into question.

After years of apparently satisfactory service, distress has been observed in some pavements with free-draining bases. Initial indications suggest problems stemming from the instability of the free-draining layer. Agencies are now concerned about the long-term stability of free-draining bases and their influence on pavement performance.

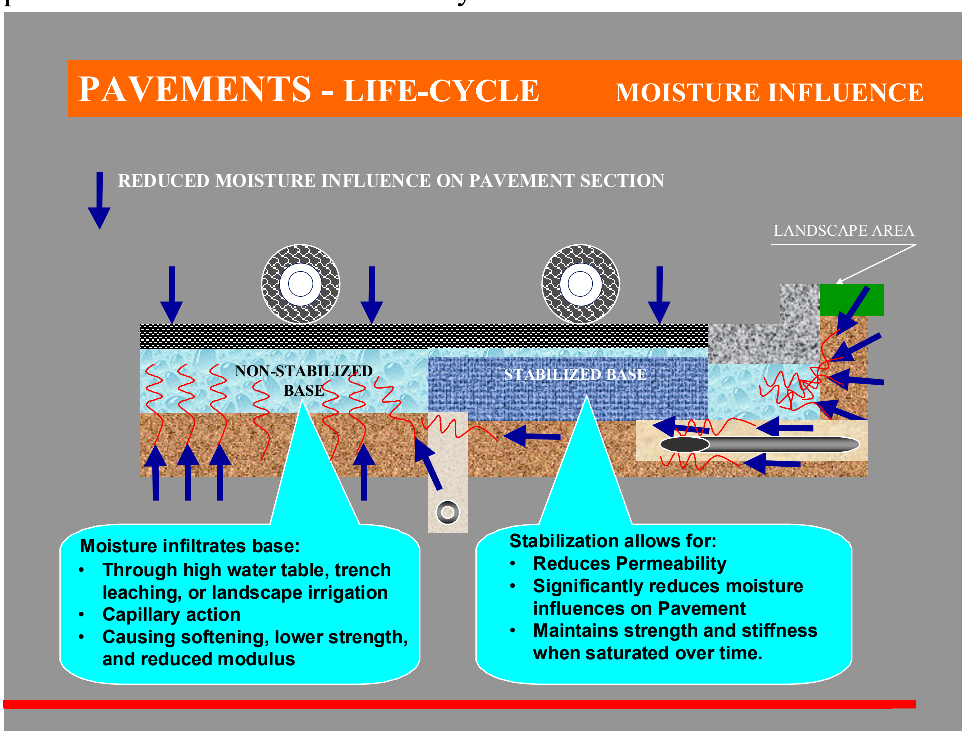
Another problem observed is that drainage from these layers is slowing over time, and there is doubt as to how long the hydraulic conductivity (permeability) of open-graded bases can be maintained because of upward migration of subgrade soil particles into the layer. Other projects that studied subsurface edge drain performance have questioned the ability of the open-graded layers to maintain their long-term hydraulic conductivity due to the reported contamination from an increase in the amount of fines in the drainage system. Therefore, another problem is the ability to maintain the integrity of the drainable layer.

Some agencies have reported success with separator layers that keep the fines out of the drainable base. A well-established separator consists of a low permeable chemically treated subgrade. A properly constructed chemically treated subgrade maintains an unconfined compressive strength and wear durability that limits lost of fines from migrating water.

While the use of a dedicated drainage layer allows the designer to assign drained strength parameters to pavement structural layers around the drainage layer, designers have not had good design strength numbers, or structural coefficients, to assign to the drain layer itself. For existing AASHTO pavement design methods and with the move towards the use of mechanistic-empirical pavement design procedures, there is a need to characterize the structural response of these layers using more fundamental material inputs, such as layer modulus and Poissons ratio. There is also a related need to predict how these material properties change over time.

The increased emphasis on the use of free-draining base courses makes assurance of their long-term performance characteristics very important. Premature failure of the pavement system due to contamination of drainable bases is exceedingly costly. However, if the hydraulic conductivity and stability of drainable bases can be maintained, pavement design life will be realized and very large cost savings in maintenance and rehabilitation of pavements are likely. The high cost of treated or bound open-graded base layers and the high maintenance costs associated with wet-dry or freeze-thaw cycles and structural pavement damage due to poor drainage are significant. The lack of design guidance concerning the structural strength and hydraulic conductivity of base layers is the cause of many poor pavement designs.

Subsurface pavement drainage systems are being constructed on most major highways and roadways despite the fact that no universally accepted method of design and analysis exists. Not only, do these not exist but also in many cases little is known relative to the drainability of in-place pavement materials. This lack of knowledge is further compounded by the complexity of multi-layered pavement systems including the many miles of older pavements that have been rehabilitated. Without effective analysis and design, it is quite probable that most drainage systems are far less than optimal and possibly not even cost effective. In some cases they may even be detrimental to the pavement when water is deliberately introduced to moisture sensitive soils.



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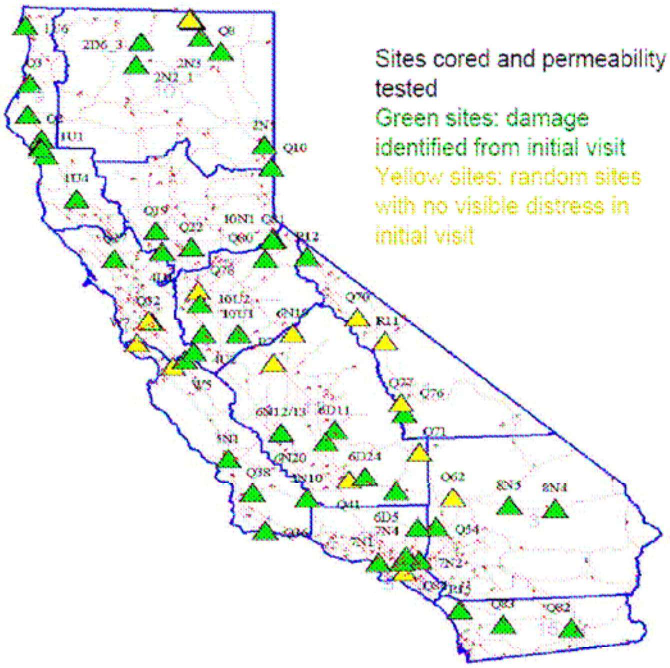
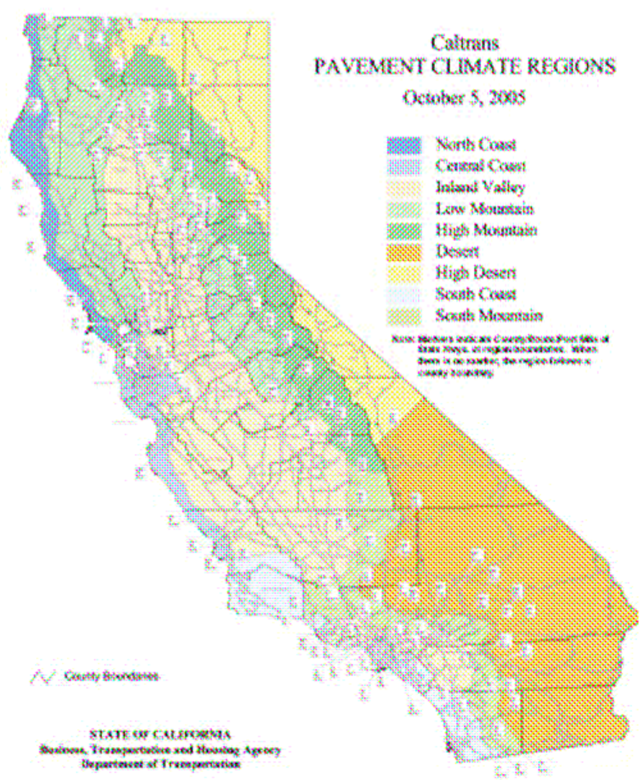


<u>Case studies revealed, that one or more factor(s) dominate moisture-related damage</u>

- **Susceptible Aggregate**
- **Moisture sensitive Subgrade Soils**
- **High air-void content combined with ample source of water**
- **Poor pavement drainage design**
- **Inappropriate Structural Design**



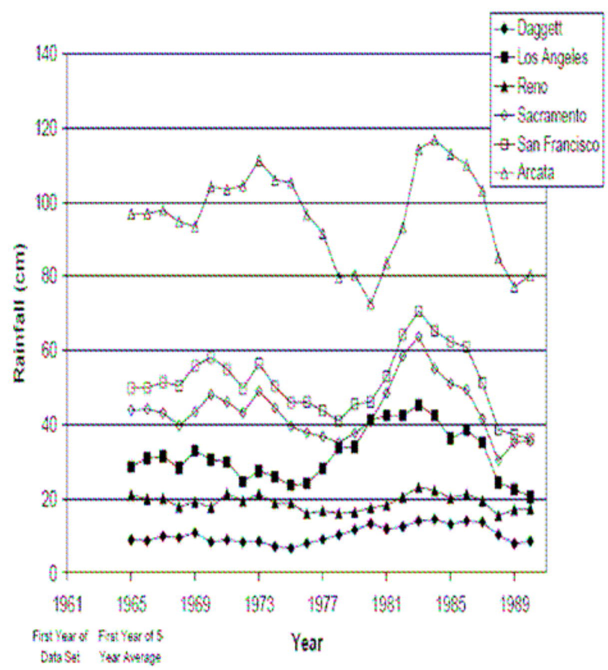


Figure 1. 5 year moving averages of rainfall for the six climate region cities.