SECTION 76 CAUSES OF STRUCTURAL FAILURE

1613. Pavement design is intended to prevent structural failure, which is caused by excessive stresses created by traffic load, either within the pavement itself or in the soil underlying it. The most important cause is deformation of the subgrade, increasing with each application of the load and resulting in failure of the layers above. However well the load may be distributed by the component parts of the pavement, the load due to the pavement structure and the traffic it carries is eventually borne by the subgrade. The moisture content of the subgrade is liable to change after the construction of the pavement, and changes may seriously affect stability. For satisfactory design, it is necessary not only to determine the required strength and thickness of pavement for a given strength of subgrade soil, but also to decide on the moisture content and degree of compaction at which the soil strength should be evaluated. Other causes of failure are the stripping of the surface, particularly when bituminous surfacings are used, and the action of frost or prolonged drought.

Changes in Soil Condition

1614. The condition of the soil may change from that existing at the time of construction in the following ways:

a. Increase in Moisture Content. In cohesive soils, the subgrade gradually tends to accumulate moisture after being covered by an impervious pavement, the degree of accumulation depending on the efficiency of drainage. Increase in moisture content nearly always leads to a decrease in soil strength.

b. Decrease in Moisture Content. A prolonged drought, or the presence of fast growing trees, may lead to a decrease in moisture content. In general, this leads to an increase in strength but, in the case of clay soil, shrinkage may be caused and this may result in differential movement of a concrete slab or in the longitudinal cracking of bituminous surfaces.

c. Uneven Compaction. The action of traffic may cause uneven settlement of a subgrade that is not uniformly compacted, leaving local areas of pavement unsupported. As a result, the pavement cracks and admits water to the subgrade, thus further reducing its strength.

d. Frost Action. Some soils are highly susceptible to frost action. During prolonged and severe frost, ice lenses may form in the upper soil layers and cause upheaval of the surface. More serious damage may occur when the ice lenses melt, when rapid softening of the subgrade must be expected. Frost-susceptible materials in the pavement make the surface permeable and admit surface water to the subgrade. Frost susceptible materials include:

(1) Clays of Palsticity Index of less than 20%.

(2) Silt.

(3) Granular soils with more than 10% passing a 75 μm sieve.

(4) Limestone gravel with greater than 2% saturation moisture content.

(5) Crushed limestone with greater than 3% saturation moisture content.

(6) All crushed chalks.

(7) Burnt colliery shale and some pulverised fuel ash. Where the subgrade is frost susceptible, the total thickness of pavement should not be less than 450 mm. The frost susceptibility of soils is described in Military Engineering Volume IV Soils and Construction Materials.