

## **CHAPTER TWO**

## **CHAPTER THREE**

## **BACKGROUND AND LITERATURE REVIEW**

### **2.1 Background**

An airfield pavement must be able to support loads imposed by aircraft without excessive distortion or failure .It should be smooth, firm, stable, and free from dust or other particles that might be blown or pushed up by propeller wash or jet blast. It must be usable in all season and in all weather conditions. The ability for a pavement to perform these functions for given aircraft traffic depends on the foundation or sub-grade, the quality of construction materials and workmanship, the design or proportioning of the materials in the pavement mix, and the thickness of the layers of the pavement system.

### **2.2 Major Pavement Types**

There are three major types of pavements flexible or asphalt pavements, rigid or concrete pavements, and composite pavements.

#### **1. Flexible Pavement**

Flexible pavements are so named because the total pavement structure deflects, or flexes, under loading. A flexible pavement structure is typically composed of several layers of materials. Each layer receives loads from the above layer, spreads them out, and passes on these loads to the next layer below. Thus the stresses will be reduced, which are maximum at the top layer and minimum on the top of sub-grade. In order to take maximum advantage of this property, layers are usually arranged in the order of descending load bearing capacity with the highest load bearing capacity material (and most expensive) on the top and the lowest load bearing capacity material (and least expensive) on the bottom. For flexible pavements, structural design is mainly concerned with determining appropriate layer thickness and composition. The main design factors are stresses due to traffic load and temperature variations. Figure (3-6) show typical flexible pavement cross-section.

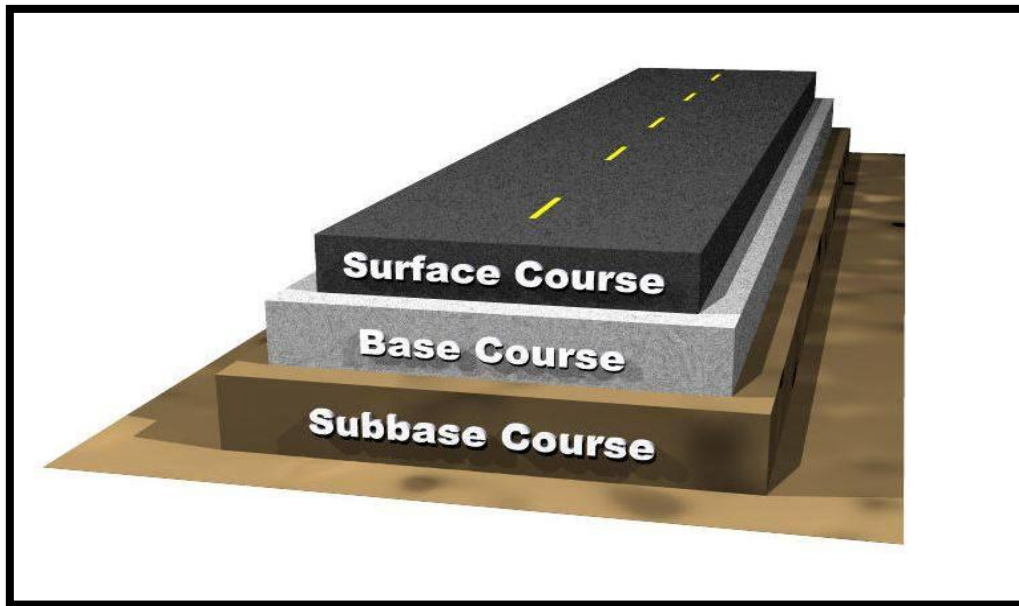


Figure (3-6) typical flexible pavement cross-section

## 2. Rigid Pavements

Rigid pavements for airports are constructed from a thickness of PCC laid on a granular or treated sub-base course supported by a compacted sub-grade. In contrast to flexible Pavements, rigid pavements are placed either directly on the prepared sub-grade or on a single layer of granular or stabilized material. Because there is only one layer of Material under the concrete and above the sub-grade, some call it a base course, others a sub-base. Figure (3-7), showing typical rigid pavement cross -section.

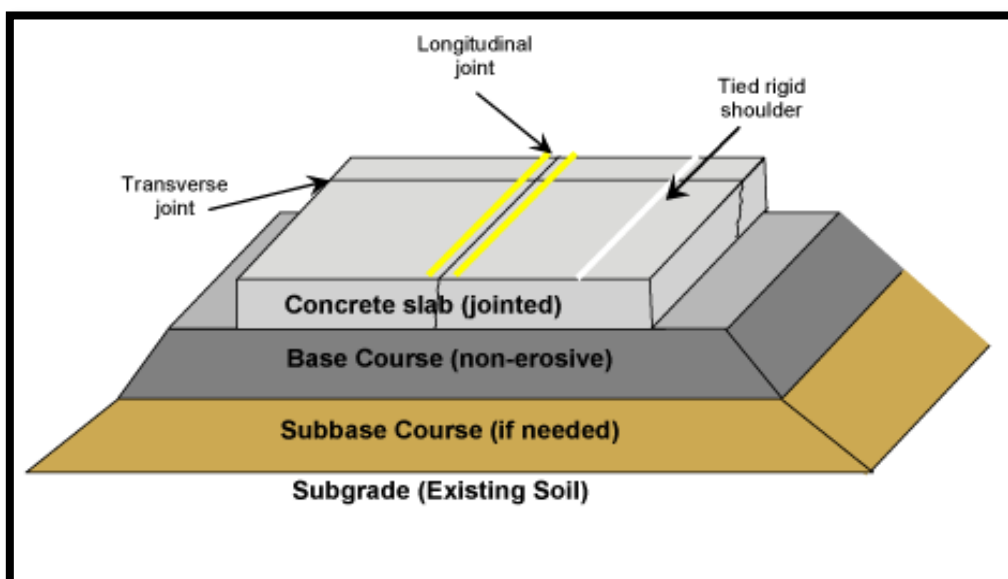


Figure (3-7) typical rigid pavement cross-section.

### **3. Composite Pavements**

A composite pavement is composed of both HMA and PCC. The use of PCC as a bottom layer and HMA as a top layer results in an ideal pavement with the most desirable characteristics. The PCC provides a strong base and the HMA provides a smooth and no reflective surface. However, this type of pavement is very expensive and it rarely used as a new construction. Composite pavements are usually rehabilitation of concrete pavements using asphalt overlays.

#### **2.3 Airport Pavement Courses**

**(1) Surface:** Surface courses include Portland cement concrete (PCC), hot mix asphalt (HMA), sand-bituminous mixture, and sprayed bituminous surface treatments.

**(2) Base:** Base courses consist of a variety of different materials, which generally fall into two main classes, treated and untreated. An untreated base consists of crushed or uncrushed aggregates. A treated base normally consists of a crushed or uncrushed aggregate mixed with a stabilizer such as cement, bitumen, etc.

**(3) Sub-base:** Sub-base courses consist of a granular material, a stabilized granular material, or a stabilized soil.

#### **2.4 Material for Flexible and Rigid Airports Pavement:**

Adherence to this design principle makes possible the use of local materials and usually results in a most economical design. This is particularly true in regions where high-quality materials are expensive. The materials of each course of pavement (flexible, rigid) are the following:

##### **1. Surface Materials**

The following points illustrate the materials used in pavement for surface layer:

- P-501, Portland cement Concrete Slab.
- 2- P-401, Hot Mix Asphalt Surfacing.

##### **2. Base materials**

The following points illustrate the materials used in pavement for base layer:

- Item P-154 – uncrushed aggregate.
- Item P-208 – Aggregate Base Course.

- Item P-209 – Crushed Aggregate Base Course.
- Item P-211 – Lime Rock Base Course.
- Item P-301 – Soil Cement Base.
- Item P-304 – Cement Treated Base Course.
- Item P-306 – EConcorete Sub-base Course.
- Item P-401 – Plant Mix Bituminous Pavements.
- Item P-403 – HMA Base Course.

### **3. Sub-base materials**

The following points illustrate the materials used in pavement for sub-base layer:

- P-304 – Cement Treated Base Course
- P-306– E concrete Sub-base Course
- P-401 and P-403 –Plant Mix Bituminous Pavements
- P-154 – Sub-base Course
- P-213 – Sand Clay Base Course
- P-301 – Soil Cement Base Course.

### **2.5 Pavement performance**

Airport pavements are complex structural systems, and their performance depends on a broad spectrum of variables. These variables are classified into five groups, listed below.

1. Load variables
  - Aircraft gross load
  - Wheel load
  - Number and spacing of wheels
  - Tire contact pressures
  - Number of applications
  - Duration of load application
  - Distribution of lateral placement of loads
  - Type of load (static or dynamic)
2. Environmental variables
  - Amount and distribution of precipitation (especially rainfall)
  - Ambient temperatures.
  - Aircraft blast and heat
  - Fuel spillage

### 3. Structural design variables

- Number, thickness, and type of pavement layers
- Strength of materials
- Construction variables
- Maintenance variables

The task of the pavement designer is complicated by the rapidly changing state of aircraft design technology. The introduction of larger and heavier aircraft as well as changes in wheel loads, gear configurations, tire pressures, and other load variables significantly affect the performance of airport pavements.

A pavement's performance is especially sensitive to the frequency of loadings. Areas subjected to repeated loadings due to channelization or concentration of traffic must be designed to accommodate the stress from such loadings.

### 4. The environmental variables that affect the performance of a pavement include:

- Amount and distribution of precipitation, which may weaken sub-grades and contribute to pavement pumping and frost action
- Ambient temperatures, which can cause excessive expansion of concrete slabs and asphalt softening and bleeding
- Variables associated with the aircraft, such as jet blast, heat, and fuel spillage.
- Type of sub-grade soil.
- The performance of a pavement is directly related to its structural design. Structural design variables include the number and thickness of the pavement layers and the strength and behavioral characteristics of the pavement materials. It should also be obvious that performance under service conditions depends on the quality of construction workmanship and the adequacy of maintenance during its service life. Therefore, the designer should make suitable allowances for probable inadequacies in quality control during construction and should consider the effects of the anticipated level of maintenance.

## **2.6 Soil Investigation and Evaluation**

The importance of accurate identification and evaluation of pavement foundations cannot be overemphasized. Although it is impossible to explore the entire field of soil mechanics in a publication.

**Distribution and Properties:** To provide essential information on the various types of soils, investigations should be made to determine their distribution and physical properties. This information combined with data on site topography and area climatic records, provides basic planning material essential to the logical and effective development of the airport. An investigation of soil conditions at an airport site will include:

- **Subsurface Soil Profile:** An investigation of subsurface soil properties to determine the arrangement of different layers of the soil with relation to the proposed sub-grade elevation.
- **Sampling:** Collection of representative samples of the layers of soil.
- **Testing:** Testing of samples to determine the physical properties of the various soil materials with respect to in-place density and sub-grade support.
- **Availability:** A review to determine the availability of materials for use in construction of the sub-grade and pavement.

Soil investigation consists of a soil survey to determine the arrangement of the different layers of soil in relation to the sub-grade elevation, a sampling and testing of the various layers of soil to determine the physical properties of the soil, and a survey to determine the availability and suitability of local materials for use in the construction of the sub-grade and pavement. Surveys and sampling are usually accomplished through soil borings to determine the soil of rock profile and its lateral extent. The sampled materials are then tested to determine soil types, gradation or particle size, liquid and plastic limits, moisture-density relationship, shrinkage factors, permeability, organic content, and strength properties. The FAA recommends boring of given spacing and depths for soil surveys as illustrated in Table 1.1.

**Table 2.1:** Recommended Soil Boring Spacing and Depths

Depth	Spacing	Area
Runways and taxiways	Random across pavement at 200 ft (68) intervals	Cut areas —10ft (3.5m) below finished grade Fill areas — 10ft (3.5m) Below existing ground
Other areas of pavement	One boring per 10,000 ft <sup>2</sup> (930m <sup>2</sup> ) of area	Cut areas —10ft (3.5m) below finished grade Fill areas — 10ft (3.5m) Below existing ground
Borrow areas	Sufficient tests to clearly define the borrow material	To depth of borrow excavation

## 2.7 California Bearing Ratio (CBR)

The CBR test is a penetration test conducted at a uniform rate of strain. The force required to produce a given penetration in the material under test is compared to the force required to produce the same penetration in a standard crushed limestone. The result is expressed as a ratio of the two forces. Thus, a material with a CBR value of 15 means the material in question offers 15 percent of the resistance to penetration that the standard crushed stone offers. Laboratory CBR tests should be performed in accordance with ASTM D 1883, Bearing Ratio of Laboratory-Compacted Soils. Field CBR tests should be conducted in accordance with the ASTM D 4429, Standard Test Method for Bearing Ratio of Soils in Place.

## 2.8 The Plate Bearing Test

The modulus sub-grade of reaction or  $k$  value of the sub-grade is determined by what is known as a field plate bearing test. This test consists of applying loads by means of a hydraulic jack through a jacking frame on to a steel plate 30 in diameter on the soil. By loading the plate, a load-versus-deformation curve is obtained. The  $k$  value is determined to be the pressure required to produce a unit deflection of the pavement foundation, measured in pounds per cubic inch.  $k$  values range from less than 150 (considered "very good") to more than 300 (considered "very good"). In general, the greater the coarseness of the soil, the higher  $k$  value and the less deflection for a given loading can be expected.  $k$  values in this research is founded by the equation below

$$k = \left[ \frac{1500 \times \text{CBR}}{26} \right]^{0.7788}, \quad (k \text{ in pci}) \quad \text{--- (2.1)}$$