To Study and Design of Airport Runway Pavement

Sanjeev Gill , Dr. Rajiv Kumar, Shivam Singhal, Rahul Kumar, Rishi Raj Mani, Subham Srivastav, Purushottam

HOD Department of Civil Engineering, JBIT, Dehradun  
JBIT B-TECH Final year Students

ABSTRACT

The structural design of airport runway pavements are material design and thickness design. Material design deals with the selection of suitable materials for various pavement layers and mix design of bituminous materials. Pavements are designed and constructed to provide durable all-weather travelling surfaces for safe and speedy movement of people and goods with an acceptable level of comfort to users. These functional requirements of pavements are achieved through careful considerations in the following aspects during the design and construction phases: (a) types of pavement (b) grading of material (c) design of pavement thickness. Airport facility requirements include runways, taxiways, pavement condition, navigational aids, lighting systems, and aircraft parking apron, hangars, fixed base operator (FBO) facilities, aircraft fuelling, automobile parking, utilities and surface access.

Keys: flexible pavement, rigid pavement, run way, pavement surface, parking, apron area

INTRODUCTION

An airport runway is defined as a rectangular area on a land prepared for the landing and takeoff of aircraft. Runways may be a man-made surface (often asphalt, concrete, or a mixture of both) or a natural surface (grass, dirt, gravel, ice, or salt). Runways are named by a number between 01 and 36, which is generally the magnetic azimuth of the runway's heading in deca degrees: a runway numbered 09 points east (90°), runway 18 is south (180°), runway 27 points west (270°) and runway 36 points to the north (360° rather than 0°). When taking off from or landing on runway 09, a plane would be heading 90° (east). A runway can normally be used in both directions, and is named for each direction separately: e.g., “runway 33” in one direction is “runway 15” when used in the other. The two numbers always differ by 18 (± 180°).

Types of Pavement for air port run way

- Flexible pavement
- Rigid pavement

Flexible pavements: Flexible pavements are those which on the whole have low or negligible flexural strength and are rather flexible in their structural action under the loads. The flexible pavement layers reflect the deformation of the lower layers on to the surface of the layer. Thus if the lower layer of the pavement or soil subgrade is undulated, the flexible pavement surface also gets undulated. The flexible pavements consist of asphalt concrete surface built over a base course and they rest on subgrade.

Layered structure for flexible pavement

- Wearing course
- Binder course
- Sub base course
- Soil formation bed
- Natural ground surface

Rigid Pavement: Rigid pavements are those which possess note worthy flexural strength or flexural rigidity. The stresses are not transferred from grain to grain to the lower layers as in the case of flexible pavement layers. Rigid pavements are made up of Portland cement concrete-either plain, reinforced or prestressed concrete.

Layered structure for rigid pavement

- Concrete slab
- Sub base course
- Soil formation bed
Natural ground surface

Traffic volume & loading analysis for Airport runway pavement

The airport pavements differ slightly from that for highway pavements due to differences in traffic operations and functional uses of the pavements. The basic steps are

- Estimation of traffic stream composition
- Estimation of expected initial year traffic volume
- Estimation of design traffic loading for different operation functional areas
- Estimation of expected annual traffic growth density rate

Types of airport runways

There are three types of runways:

- **Visual runways** are used at small airstrips and are usually just a strip of grass, gravel, ice, asphalt, or concrete. Although there are usually no markings on a visual runway, they may have threshold markings, designators, and centerlines. Additionally, they do not provide an instrument-based landing procedure; pilots must be able to see the runway to use it. Also, radio communication may not be available and pilots must be self-reliant.

- **Non-precision instrument runways** are often used at small- to medium-size airports. These runways, depending on the surface, may be marked with threshold markings, designators, centerlines, and sometimes a 1,000 ft (305 m) mark (known as an aiming point, sometimes installed at 1,500 ft (457 m)). They provide horizontal position guidance to planes on instrument approach via Non-directional beacon, VHF omnidirectional range, Global Positioning System, etc.

- **Precision instrument runways** which are found at medium- and large-size airports, consist of a blast pad/stopway (optional, for airports handling jets), threshold, designator, centerline, aiming point, and 500 ft (152 m), 1,000 ft (305 m)/1,500 ft (457 m), 2,000 ft (610 m), 2,500 ft (762 m), and 3,000 ft (914 m) touchdown zone marks. Precision runways provide both horizontal and vertical guidance for instrument approaches.

Runway Dimensions

Runway dimensions vary from as small as 245 m (804 ft) long and 8 m (26 ft) wide in smaller general aviation airports, to 5,500 m (18,045 ft) long and 80 m (262 ft) wide at large international airports built to accommodate the largest jets. A runway of at least 1,829 m (6,000 ft) in length is usually adequate for aircraft weights below approximately 90,718 kg. Larger aircraft including wide bodies will usually require at least 8,000 ft (2,438 m) at sea level and somewhat more at higher altitude airports. International wide body flights, which carry substantial amounts of fuel and are therefore heavier, may also have landing requirements of 10,000 ft (3,048 m) or more and takeoff requirements of 13,000 ft (3,962 m). At sea level, 10,000 ft (3,048 m) can be considered an adequate length to land virtually any aircraft. An aircraft will need a longer runway at a higher altitude due to decreased density of air at higher altitudes, which reduces lift and engine power, the former requiring higher takeoff and landing speed. An aircraft will also require a longer runway in hotter or more humid condition.

1) Pavement Surface

Runway pavement surface is prepared and maintained to maximize friction for wheel braking. To minimize hydroplaning following heavy rain, the pavement surface is usually grooved so that the surface water film flows into the grooves and the peaks between grooves will still be in contact with the aircraft tires. To maintain the macro texturing built into the runway by the grooves, maintenance crews engage in airfield rubber removal or hydro cleaning in order to meet required FAA friction levels.

Pavement

The choice of material used to construct the runway depends on the use and the local ground conditions. For a major airport, where the ground conditions permit, the most satisfactory type of pavement for long-term minimum maintenance is concrete. Although certain airports have used reinforcement in concrete pavements, this is generally found to be unnecessary, with the exception of expansion joints across the runway where a dowel assembly, which permits relative movement of the concrete slabs, is placed in the concrete. Where it can be anticipated that major settlements of the runway will occur over the years because of unstable ground conditions, it is preferable to
install asphaltic concrete surface, as it is easier to patch on a periodic basis. For fields with very low traffic of light planes, it is possible to use a sod surface. Some runways also make use of salt flat runways.

Airport pavements have been designed by two methods.

- Westergaard’s method
- California bearing ratio method

Runway Markings

There are runway markings and signs on most large runways. Larger runways have a distance remaining sign (black box with white numbers). This sign uses a single number to indicate the thousands of feet remaining, so 7 will indicate 7,000 ft (2,134 m) remaining. The runway threshold is marked by a line of green lights.

![Runway Markings Diagram](image)

Runway lighting is used at airports that allow night landings. Seen from the air, runway lights form an outline of the runway. A particular runway may have some or all of the following

- **Runway end identifier lights** (REIL) – unidirectional (facing approach direction) or omnidirectional pair of synchronized flashing lights installed at the runway threshold, one on each side.
- **Runway end lights** – a pair of four lights on each side of the runway on precision instrument runways, these lights extend along the full width of the runway. These lights show green when viewed by approaching aircraft and red when seen from the runway.
- **Runway edge lights** – white elevated lights that run the length of the runway on either side. On precision instrument runways, the edge-lighting becomes yellow in the last 2,000 ft (610 m) of the runway, or last third of the runway, whichever is less. Taxiways are differentiated by being bordered by blue lights, or by having green centre lights, depending on the width of the taxiway, and the complexity of the taxi pattern.
- **Runway centerline lighting system** (RCLS) – lights embedded into the surface of the runway at 50 ft (15 m) intervals along the runway centerline on some precision instrument runways. White except the last 900 m (3,000 ft): alternate white and red for next 600 m (1,969 ft) and red for last 300 m (984 ft).
- **Touchdown zone lights** (TDZL) – rows of white light bars (with three in each row) at 30 or 60 m (98 or 197 ft) intervals on either side of the centerline for 900 m (3,000 ft).
- **Taxiway centerline lead-off lights** – installed along lead-off markings, alternate green and yellow lights embedded into the runway pavement. It starts with green light at about the runway centerline to the position of first centerline light beyond the Hold-Short markings on the taxiway.
- **Taxiway centerline lead-on lights** – installed the same way as taxiway centerline lead-off Lights, but directing airplane traffic in the opposite direction.
- **Land and hold short lights** – a row of white pulsating lights installed across the runway to indicate hold short position on some runways that are facilitating land and hold short operations (LAHSO). **Approach lighting system** (ALS) – a lighting system installed on the approach end of an airport runway and consists of a series of light bars, strobe lights, or a combination of the two that extends outward from the runway end.

According to Transport Canada's regulations, the runway-edge lighting must be visible for at least 2 mi (3 km).

Arpor

The **airport apron** is the area of an airport where aircraft are parked, unloaded or loaded, refueled, or boarded. Although the use of the apron is covered by regulations, such as lighting on vehicles, it is typically more accessible to users than the runway or taxiway. However, the apron is not usually open to the general public and a license may be required to gain access. The use of the apron may be controlled by the apron management service (apron control or apron advisory) to provide coordination between the users.
CONCLUSION
According to the previous airport runway designs flexible pavement is better than rigid (concrete) pavement. Due to the reason that with the exception of expansion joints across the runway where a dowel assembly, which permits relative movement of the concrete slabs, is placed in the concrete. Due to this reason flexible pavement is generally used in airport runway pavement. Rearrangement of dowel bars in rigid pavement should be applied to short out this type of problems in rigid pavement of airport runway.

REFERENCES