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COMPARATIVE ANALYSIS OFHIGHWAY DESIGN

Specialization in
TRANSPORTATION ENGINEERING

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ABSTRACT

One of the most important uses of civil engineering is the design, construction, and upkeep of new highways. Surveying, technology, compaction of earth work, grading of the road surface, and other fundamentals are all necessary when building new roads. are precise and executed with assurance.Future chapters will aim to compare topics like lying of the WBM layer and WMM layer, which are related to my project work.

Different design techniques are applied in the construction of highways. Pavement design methodology, rigid pavement design research, geometric design approach, and ongoing work under modifications. The upcoming road testing and maintenance are also covered in the chapters that follow. These are not only the highlights of my project and training work; they are not my academic curriculum.

CHAPTER 1

IINTRODUCTION

Highway engineering is a subfield of civil engineering that deals with the design, planning, building, operating, and maintaining of highways, bridges, and other & tunnels to guarantee the efficient and safe movement of both people and products. Following World War 2, highway engineering gained popularity in the second part of the 20th century.

The standards for highway engineering are always being raised. Future traffic patterns, intersection and interchange design, geometric alignment and design, pavement materials and design, structural design of pavement thickness, and pavement maintenance are all factors that highway engineers must consider.

HISTORY

One could argue that road building started during the Roman era. Road development has to keep up with the technological advancements from two-horse-pulled carriages to vehicles with 100 horses' worth of power. It was not until the late 19th and early 20th centuries that modern highway construction got underway.

The first highway engineering-focused research was initiated in the United Kingdom in 1930 with the founding of the Transport Research Laboratory (TRL).Highway engineering became increasingly well-known in the US when the Federal-Aid Highway Act was passed in 1944. This act aimed to connect 90% of cities with a population of 50,000 or more. Over time, pavements will need to be improved due to the continuous pressure from larger cars. The Preston bypass, the nation's first highway, was constructed in 1958 due to antiquated technology, and its construction had a major influence on the development of contemporary pavement technology.

In the United States, research and publications from the American Association of State Highway and Transportation Officials, which are distributed by the Department of Transportation, the Federal Highway Administration, the Institute of Transportation Engineers, and the Transportation Research Board, are typically the source of design standards and norms.

1.1 DEVELOPMENT AND PLANNING

The assessment of present and future traffic volumes on a road network is a component of highway planning. The goal of highway engineers is to Identify and evaluate every potential civil impact that roadway networks may have. The detrimental effects on the environment, such as air, water, noise, and other ecological consequences, are some factors to take into account.

1.2 FUNDING

The high maintenance costs associated with aged transportation routes are a persistent problem for developed nations. There is a growing demand for safer, more efficient, and less crowded highways as a result of the expansion of the motor vehicle industry and the corresponding economic growth. In the past, government budgets have been heavily utilized by the expansion of business, education, housing, and defense, which made funding public roads difficult. The economy, the multipurpose nature of highways, and the developments in highway pricing technology are all ever- evolving. As a result, methods for managing, funding, and maintaining highways are also continually evolving.

1.3 SAFETY ON THE ROADS

Highway systems bear the brunt of human injury and mortality; even accounting for the 1.2 million fatalities, they inflict pain on up to 50 million people annually. The primary cause of unintended mortality during the first fifty years of life is traffic-related injuries.

The deliberate safety management strategy seeks to reduce the number and severity of traffic accidents. The management of highway safety is hampered by the volatility of machine interactions with road traffic systems. To increase the level of safety, highway systems must be designed, built, and maintained to be far more tolerant of the average range of this machine contact with highways. Technological advancements in highway engineering have improved design, construction, and maintenance methods over time. These accomplishments have enabled morerecent advancements in traffic safety.

In order to increase the safety of our road systems, every stage of highway planning, design, and construction can be examined to ensure that all possibilities and situations are identified, considered,and applied as needed.

1.4 DESIGN

During the design phase, the best possible location, alignment, and geometry for a roadway are chosen. In order to build a safe route, highway design takes into account the interaction of three main factors: human, vehicle, and roadway. Human aspects include following cars, reaction times for braking and turning, and visual acuity for traffic signs and signals. When choosing design cars and defining lane widths and maximum slopes, vehicle dynamics and size are crucial factors to take into account. When designing two-lane, two-way highways, highway engineers take care to ensure that vehicles are stable when navigating curves and hills and that there are sufficient sight distances to allow for passing movements along curves.

1.5 PREREQUISITES FOR A PAVEMENT

The pavement needs to adhere to the following specifications:

- Enough thickness to equally divide the wheel load strains on the subgrade soil to a safe level robust enough structurally to endure any kind of stress placed on it.
- Sufficient coefficient of friction to avoid automobiles from sliding.
- A smooth surface that makes reading comfortable even for fast readers.
- Dust-proof surfaces ensure that visibility does not compromise traffic safety; impermeable surfaces safeguard the subgrade.
- Long design life and minimal upkeep.

CHAPTER -2 ASPHALT PAVEMENT DESIGN

Asphalt began to play a significant role in our everyday lives a few years ago. Even if we don't realize it, asphalt roads are used whenever we travel or make a purchase.

Approximately 6.1 million kilometers of paved roads make up the European road network, and 90% of these roads are asphalt-paved. The remaining 10% is composed of pavers, such as bricks and cobblestones, and concrete. In addition, asphalt is utilized in tennis courts, playgrounds, running tracks, railroad beds, airport runways,bridges, tunnels, etc.

2.1 ASPHALT PAVEMENT COMPOSITION

Aggregates, binder, and filler are combined to create asphalt. For asphalt, aggregates can be slags, crushed rock, sand, or gravel. Bitumen is employed as a binder to bring all the particles together into a cohesive slurry. The typical asphalt pavement design is made up of several layers. The sub-grade, or existing soil, makes up the bottom layer.

The base layer of aggregate is the next layer, and it is occasionally stabilized with fly ash, cement, or asphalt. One or more layers ofasphalt pavement are layered over this.

These layers serve the primary purpose of enabling the pavement to disperse the loads and created stresses and strains prior to the pavement reaching the foundation level. Additionally, the pavement structure may withstand extensive plastic deformation due to the viscous nature of bitumen, yet the most typical cause of failure is fatigue from repeated loads.

2.2 ADVANTAGES OF ASPHALT

There are numerous advantages to asphalt pavement surfaces.

Smoothness and comfort: The building method of multiple-layer pavements offers a perfectly smooth structure, which makes the road user feel comfortable.

2.2.1 ECONOMICAL STRUCTURE

Compared to alternative pavements, asphalt has a higher residual value since it is more recyclable, lasts longer, and has lower initial expenses. Water can percolate through porous asphalt pavements due to its design. Asphalt surfaces can also greatly lower noise levels both insideand outside of cars.

2.2.2 SAFETY

In order to prevent floods and aquaplaning, asphalt structures quickly drain surface water. This also improves driver visibility in these situations. Additionally, it increases the vehicle's wheels' traction so they don't slip on pavement.

2.2.3 DURABILITY

Depending on the amount of traffic they are expected to see, roadways are typically built to last 15 to 20 years. The old wearing course is recycled into a fresh layer of asphalt when it has to be replaced. Certain well-maintained and built highways may last longer before requiring complete replacement.

2.2.4 QUICK CONSTRUCTION

Since asphalt pavement doesn't require a "cure" period, there are fewertraffic delays and shorter construction times.

- **Reusability:** Bitumen needs to be used less while rebuilding roads because asphalt is one of the most recyclable building materials in Europe.

- **Flexibility:** Roadways may be built to withstand any amount oftraffic and any type of weather.

CHAPTER -3 GEOMETRIC DESIGN OF HIGHWAYS

The field of highway engineering known as "geometric design" is concerned with the actual placement of the roadway's physical components within the confines of standards and regulations. The fundamental goals of geometric design are to maximize safety and efficiency while minimizing costs and environmental harm. Additionally, geometric design has an impact on an emerging fifth objective known as "livability," which is defined as designing roads to support broader community goals, such as facilitating access to jobs, schools, businesses, and residences; accommodating a variety of travel modes, including bicycles, walking, transit, and automobiles; and minimizing fuel use, emissions, and environmental harm.

Although designing and building a road's pavement in phases is feasible, improving a road's geometric aspects gradually and at a later time is highly costly.

3.1 HIGHWAY GEOMETRIC DESIGN TAKES INTOACCOUNT THE FOLLOWING FACTORS:

(A) CROSS SECTION ELEMENTS
(B) SIGHT DISTANCE CONSIDERATION
(C) HORIZONTAL ALIGNMENT DETAILS
(D) VERTICAL ALIGNMENT DETAILS
(E) INTERSECTION ELEMENTS

3.2.(A) CROSS SECTION:

A roadway's cross section depicts the number of lanes, their widths, and cross slopes, as well as the existence or absence of shoulders, curbs, sidewalks, ditches, drains, and other features. It can be thought of as an excavator digging a trench across the roadway.

3.3. CROSS SECTIONAL ELEMENTS

Camber is a cross slope that is designed to elevate the center of the road surface in a transverse orientation, allowing rainwater to drain off the surface.

Camber is used to protect the following areas:

- Surface protection, particularly for bituminous and gravel roads
- Sub-grade protection through appropriate drainage
- Quick drying of the pavement, which improves safety.

A slope that is too steep is bad because it will degrade the surface. Camber is expressed as 1 in n or n% (for example, 1 in 50 or 2%), andthe amount varies according to the kind of pavement surface. Thevalues recommended by IRC for different pavement categories areshown in the figure. Straight, parabolic, or a combination of the twoare the most frequent types of camber.

PAVEMENT OR CARRIAGEWAY WIDTH:

The width of the traffic lane and the number of lanes determine the width of the carriageway or pavement.If there is a raised curb, such as a footpath on an urban road, the lane width should be 3.75 meters. The width of a traffic lane is determined by the clearance and vehicle width. Safer and faster operation are enhanced by side clearance. For single-lane traffic, the maximum allowable width of a vehicle is 2.44 meters, while the ideal side clearance is 0.68 meters. For a single-lane road, this requires a minimum lane width of 3.75 meters. About 0.53 meters of side clearance are needed on either side, and 1.06 meters are needed in the center.

3.4. KERBS:

The line separating the carriageway from the shoulder, islands, orwalkways is indicated by kerbs.

There are several varieties of kerbs.

- **LOW OR MOUNTABLE KERBS**: These kerbs are designed to encourage motorists to stay in the through traffic lanes while yet making it easy for drivers to enter the shoulder area. This kerb's height is roughly 10 cm above the pavement's edge, and its slope makes it simple for cars to drive up. This aids in longitudinal drainage and is typically offered at medians and channelization schemes.

- **SEMI-BARRIER TYPE KERBS:** These kerbs are installed in areas with heavy foot traffic. They are 15 cm above the edge of the pavement. Although parking cars cannot encroach with this kind of kerb, it can be somewhat difficult to drive over in an emergency.

- **BARRIER TYPE KERBS:** The purpose of barrier-style kerbs is to deter cars from pulling off the pavement. They are offered when there is a significant volume of foot traffic. They are positioned with the step better at a height of 20 cm above the pavement edge.

3.5 SIGHT DISTANCE:

A driver's ability to see the road ahead of them is crucial to the safe and effective operation of a vehicle on the road. Therefore, every obstruction on the road's length should be evident to drivers from a distance ahead thanks to the geometric design of the road. The seeing distance is defined as this distance.

TYPES OF SIGHT DISTANCE:-

The actual distance along the road surface that a motorist from a given height above the carriage way has visibility across is known as the sight distance accessible from a position.

View of moving or stationary things. When designing, three sightdistance scenarios are taken into account:

- Stopping sight distance (SSD), also known as the absoluteminimum sight distance
-

The definition of intermediate sight distance (ISD) is twice SSD

-

The Overtaking Sight Distance (OSD) is necessary for a safeovertaking maneuver.

-

Headlight sight distance refers to the amount of space that a drivercan see when driving at night while using headlights.

- It also includes safe sight distance when entering an intersection.

- The most crucial factor in all of these is that the motorist must always have enough roadway in order to travel at the highway's design speed.

• Distance inside his field of vision to give him time to stop his car before running into a stationary or slowly moving object that unexpectedly appeared in his own traffic lane.

• A driver's reaction time is the amount of time that passes between when they see an obstacle and when they apply the brakes. The entire reaction time can be divided into four parts using the PIEV theory. In actuality, all of these periods are typically integrated into a total perception-reaction time that is convenient to measure and appropriate for design purposes.

• Numerous studies demonstrate that, in typical circumstances, drivers need between 1.5 and 2 seconds. But keeping in mind the unpredictability.

• Vehicle speed: The vehicle's speed has a significant impact on the sight distance. The vehicle will take longer to stop at a higher speed.

3.6. HIGHWAY ALIGNMENT:

The alignment is the location of the highway's Center line layout on the ground.Highway alignment consists of both horizontal and road's vertical alignment. The straight path, deviations, and horizontal curves are all included in the horizontal alignment. The vertical alignment of highways includes changes in gradient and vertical curves.

CHAPTER - 4 HIGHWAY MATERIAL AND TESTS

From the earliest days of the Roman Empire, the materials used to build roadways have advanced with time. Improvements in the techniques used to handle these materials. This breakthrough in materials has been characterized and applied to pavement structural design.

Pavement surfaces can be divided into two main categories

(a) Concrete made of Portland cement (PCC)
(b) HMA, or hot-mix asphalt.

The material layers in this wearing course provide the pavement system with structural support. The aggregate base and subbase layers, the treated base and subbase layers, and the underlying natural or treated subgrade are examples of these underlying surfaces.

For extra support, these treated layers can be treated with lime, cement, or asphalt.

4.1. COMPONENTS OF HIGHWAY :-

(A) EMBANKMENT OR FILL

(B) SUBGRADE

(C) PAVEMENT LAYER OF FLEXIBLE OR RIGID STRUCTURE

4.2. MATERIAL USED IN HIGHWAYS:

A. **SOIL:** Suitable for a highway embankment or fill.

B. **STONE AGGREGATES:** An aggregate is a constituent of a composite material that gives it bulk and the ability to withstand compressive stress.

- Aggregate should have a large range of sizes but be much smaller than the final product for effective filling.Both sand and gravel are common types of stone particles used in concrete. The size, shape, texture, and gradation of the aggregates are specified. The necessary aggregate sizes are selected in order to achieve the intended grade.

- Numerous organizations, including the IRC, BIS, ASTM, and BSI, have established specifications for the grading, testing, and specifications of stone aggregates for various road-making applications.

- Hard aggregates are favoured because they can withstand bad weather and the abrasive and crushing effects of high traffic volumes.

Soft aggregates, including slag, kankar, laterite, brick aggregates, and moorum, are utilized in the lower layer of the structure of roadpavement. Specifications and tests for soft aggregates are varied.

4.3. HIGHWAY TESTS:

1. AGGREGATES IMPACT TEST:

This test determines the material's toughness or impact resistance. Sized sieves: 12.5 mm, 10 mm, and 2.36 mm, a 75 mm diameter by 50 mm deep cylindrical metal measure, a 10 mm circular cross-section 230 mm long tamping rod with a rounded end, and an oven. After cooling, the sample needs to be oven-dried for four hours at between 100 and 110 degrees Celsius.

AGGREGATES CRUSHING TEST:

(i) For three to four hours, the aggregates that pass through a 12.5 mm sieve and are held on a 10 mm IS sieve are oven-dried at a temperature of 100 to 110 degrees.

(ii) The apparatus's cylinder is filled in three layers, each of which is tamped with 25 strokes of a tamping rod.

(iii) Aggregate weight (Weight 'A') is measured.

(iv) After levelling the aggregates' surface, the plunger is inserted. After that, the apparatus is put into the compression testing machine and loaded steadily to reach a 40t weight in ten minutes. The load is then released after this.

(v) Subsequently, the sample is passed through a 2.36mm IS Sieve, and the portion that makes it through the sieveis measured.

(vi) There should be two tests performed

THE COMBINED ABRASION TEST

The Los Angles abrasion testing machine should be filled with the test sample and the abrasive charge, then it should rotate for 1000 revolutions at a speed of 20 to 33 revolutions per minute. The material needs to be released from the test and sieved using a 1.70mm IS Sieve.

CEMENT FINENESS TEST

i. Weigh the cement to the nearest 0.01g, around 10g, and put it on the sieve.

ii. Continue to agitate the sieve by planetary, linear, and swirling motions until no more fine material is able to pass through it.

iii. Weigh the residue and, to the nearest 0.1 percent, quantify its mass as a percentage R1 of the initial quantity put through the sieve.

iv. Gently scrub all of the fine particles from the sieve's base.

v. To obtain R2, repeat the same process with a new 10g sample. Next, determine R by taking the mean of R1 and R2 and expressing the result to the nearest 0.1 percent. When there is a difference between the outcomes of more than 1 percent absolute, conduct a third sifting and determine the average of the three values

SIEVE ANALYSIS TEST

(i) A collection of IS sieves measuring 80 mm, 63 mm, 50 mm, 40 mm, 31.5 mm, 25 mm, 20 mm, 16 mm, 12.5 mm, and 10

mm, 600µm, 300µm, 150µm, 75µm, 4.75µm, 3.35µm, 2.36µm,1.18µm, and 6.3µm.

(ii) Accurately weigh the test sample using a balance or scale towithin 0.1 percent of its total weight.

SPECIFIC GRAVITY OF SOIL TEST

The weight of a material in air at a standard temperature divided by the weight of an equivalent volume of distilled water at the same temperature is known as specific gravity warmth.

The soil's specific gravity, G, is equal to (W2-W1) / [(W4–1)-(W3–W2)].

WATER ABSORPTION TEST

As per IS: 2386 (Part III) – 1963, this test aids in determining the water absorption of coarse aggregates. A sample weighing at least 2000g ought to be used for this test.

The following tools are utilized in this test: a wire basket that is plastic coated, electroplated, or perforated and is suspended from the balance by wire hangers a waterproof container to hang the basket from, Two 75 cm by 45 cm dry, soft, absorbent cloths, a shallow tray with a minimum surface area of 650 square centimeters, airtight receptacle with a capacity comparable to the oven and basket.

Water absorption = [(A – B)/B] x 100% is the formula that is utilized.

PENETRATION BITUMEN TEST:

The bituminous material's penetration is measured in tenths of millimeters (mm) by a standard needle inserted vertically into a sampleof the substance under standard temperature, load, and time conditions.

The equipment required to assess bitumen penetration is

(i) Penetrometer

(ii) Bath in water

(iii) Thermocouple bath thermometer: 0 to 440C, 0.20C gradient

PROCEDURE

(i) Raise the bitumen's softness level above the 75–100°C range.To get rid of the water and air bubbles, give it a good stir.

(ii) Fill a container with it up to a minimum of 15 mm deep abovethe anticipated penetration.

(iii) Allow it to cool for one and a half hours at a temperature ofbetween 15 and 30 oC. Then, for 11/2 hours, place it in a transfer dish in a water bath set at 25.0 + 0.1oC.

(iv) Maintain the container on the penetration apparatus's stand.

(v) Adjust the needle so that it touches the sample's surface.

(vi) Set the dial to show zero & release the needle for precisely fiveseconds using the timer as a guide.

CHAPTER-5
RIGID PAVEMENT DESIGN

Major roadways like the interstate highway system and airports are typically built with rigid pavements. They also frequently function as heavy-duty industrial floor slabs, pavements in port and harbour yards, and pavements in terminals or parks for large vehicles. Similar to flexible pavements, inflexible highway pavements are made to withstand all weather conditions and support high-speed, contemporary traffic. They serve as structural layers to distribute vehicle wheel loads in a way that the produced stresses transferred to the subgrade soil are of acceptable magnitudes, while also providing excellent riding surfaces for safe vehicular travel.

5.1 PORTLAND CEMENT CONCRETE (PCC):-

When building stiff pavement slabs, Portland Cement Concrete (PCC) is the most often utilized material. Because of its accessibility and the state of the economy, it is very popular. It is necessary to build rigid pavements to withstand repeated, heavy traffic loads. Rigid pavements typically have designed service lives of 30 to 40 years, which is roughly twice as long as flexible pavements.

One of the main design goals of rigid pavements is to minimize fatigue failure brought on by traffic's repetitive pressures. Due to the fact that a typical roadway would see millions of wheel passes during its service life, fatigue failure is widespread on large roads. Tensile stresses resulting from heat energy must be taken into account in addition to design parameters like traffic loadings. Many transportation engineers have observed that thermally induced stresses in rigid pavements can be just as strong as those imposed by wheel loadings as pavement design has advanced. Thermal stresses are crucial to the design of rigid pavements because of the relatively low tensile strength of concrete.

The construction of rigid pavements typically consists of three layers: a concrete slab, a base or subbase, and a prepared subgrade. The plan dimensions of the slab panels are carefully considered during the construction of the concrete slab, which has a direct impact on the level of thermal stresses that arise in the pavement. To regulate the behavior of cracks in the slab, thermal reinforcements must be designed in addition to the slab panels. The size of the slab panel dictate joint spacing.

5.2 JOINTED PLAIN CONCRETE PAVEMENT (JPCP)

Jointed plain concrete pavement (JPCP), jointed reinforced concrete pavement (JRCP), and continuously reinforced concrete pavements (CRCP) are the three primary forms of concrete pavements that are frequently employed. Contraction joints are used in the construction of JPCPs to guide the pavement's natural cracking. Steel reinforcement is not used in these pavements. Contraction joints and reinforcing steel are both used in the construction of JRCPs to prevent pavement cracking. The reinforcing steel firmly prevents cracking in the pavement caused by high temperatures and moisture strains. Dowel bars are usually positioned at transverse joints to help move the vehicle's weight across the cracking. Only continuous reinforcing steel is used in CRCPs to maintain the pavement's inherent transverse fractures.

- Highways have also been built using prestressed concrete pavements, however these are not as prevalent as the other three.

- Prestressed pavements partially or completely neutralize thermally produced stresses or loadings, allowing for a reduced slab thickness.

CHAPTER:-6 PAVEMENT STRUCTURE DESIGN

6.1. FAILURE TYPES

Normal methods for assessing pavement performance include fatigue cracking and rutting models. The main cause of these models is the strains and stresses brought on by high traffic loading repetitions.
Although we won't discuss them, factors like temperature, moisture, ageing, material mix design, etc. also cause pavement distress.

6.2. FATIGUE

The increasing cracking of stabilized base layers or asphalt surfacing as a result of total traffic loading that occurs repeatedly. Tensile tensions and strains in the asphalt layer's bottom zone cause this, which then rises to the top.

The primary cause of fatigue cracking in asphalt layers, which is regarded as a significant structural distress, is traffic loading. Furthermore, the way that rainwater roughens up fissures can cause major structural collapse in underlying layers, especially in granular and loose materials like the subgrade.

In order to determine the number of load repetitions before cracking, logarithmic equations are typically utilized, which take into consideration tensile stresses or strains as well as a few other characteristics specific to the chosen modal.

6.3. RUTTING:

Rutting is the term used to describe the long-term deformation of a pavement brought on by the buildup of compressive strains that are visco-plastic vertically under traffic loads. This is the result of the subgrade shifting in shear and the pavement layers gradually becoming denser. As seen in the Figure, the wheel tracks appear to have longitudinal depressions on the pavement surface. Hydroplaning risks and significant structural failure might result from significant rutting.

6.4. ADAPTABLE PAVEMENT OVERLAYARCHITECTURE

Accumulated traffic loads over a flexible pavement's service life may result in excessive rutting or cracking, poor ride quality, or insufficient skid resistance. The pavement can be kept in good condition to prevent these issues, but doing so usually comes with high maintenance expenses, or the pavement could not be structurally strong enough to support the anticipated traffic loads.

A highway's degree of serviceability is continuously checked and maintained during its lifetime. Applying an overlay to the pavement's surface is a typical technique for preserving a highway's degree of serviceability.

On flexible pavements, three common types of overlay are applied:

- Portland cement concrete,
- Asphalt-concrete
- Ultra-thin Portland cement concrete.
- On top of the flexible surface, the concrete layer of a traditional PCC overlay is positioned without boundaries. An ultra-thin PCC overlay typically has a thickness of 4 inches (10 cm) or less.

There are two main categories of flexible pavement overlay design procedures:

- Component Analysis Design
- Deflection Based Design

6.5. RIGID PAVEMENT OVERLAY DESIGN

When a rigid pavement nears the end of its useful life, the choice is between rebuilding the entire worn pavement and building an overlay layer. Considering that an overlay can be installed over a stiff pavement that is still functional, applying overlay layers more regularly is typically more cost-effective. Requirements for overlay thickness are significantly lower for a structurally sound rigid pavement than for a pavement nearing the end of its useful life. For the rehabilitation of rigid pavements like JPCP, JRCP, and CRCP, both rigid and flexible overlays are utilized.

Rigid pavement overlays are divided into three classes based on the bonding state between the pavement overlay and existing slab contact.

- Bonded overlays
- Unbounded overlays
- Partially bonded overlays

6.6. DRAINAGE SYSTEM DESIGN

The success of roadway systems depends on their proper drainage design. Sufficient drainage is essential for a road to last its whole service life, no matter how well other parts of the road are planned and built. Even in cases where a highway structure failure is not catastrophic, excess water in the structure can unavoidably cause an early breakdown. Every highway drainage system varies from site to site and can be extremely intricate. Many techniques for adequate drainage may not work in a given area due to its topography. The roadway engineer must decide in which circumstances a certain design process—typically a mix of many suitable techniques and materials to divert water away from the structure—should be used.

CHAPTER 7 CONSTRUCTION, MAINTENANCE, AND MANAGEMENT

7.1. HIGHWAY CONSTRUCTION

Subgrade preparation and thorough surveys typically come before highway construction.

Over time, the techniques and technologies used to build roadways have advanced and gotten more complex. With the development of technology, the level of skill sets needed to oversee projects involving the construction of highways has increased.

This ability varies from project to project based on elements including the complexity and nature of the project, the distinctions between projects in urban and rural areas, and the disparities between new construction and reconstruction.

There are several components of building a roadway that fall into the categories of technical and commercial components. Here are a few instances of each:

TECHNICAL ELEMENTS

- Materials
- Material quality
- Installation techniques
- Traffic

COMMERCIAL ELEMENTS

- Contract understanding
- Environmental aspects
- Political aspects
- Legal aspects
- Public concerns

Regardless of the kind of project, construction usually starts at the lowest point on the property and works its way up. By looking over theproject's geotechnical specs, details are provided about

- Current ground circumstances
- Equipment needed for grading, excavation, and movingmaterials to and from the site

- Characteristics of the materials to be dug up
- Conditions for dewatering required for below-grade work
- Requirements for shoring in excavation protection
- The amount of water needed for dust management andcompaction

7.2. SUBBASE COURSE CONSTRUCTION

A subbase course is a layer between the pavement's base course and subgrade that is made of carefully chosen materials. The
Subbase is intended to provide the necessary structural capacity of the pavement portion and is typically 4 to 16 inches thick.
Crushed stone, gravel, or subgrade soil stabilized with fly ash, lime, or cement are common materials used for a highway subbase. The capacity of permeable subbase courses to remove intruding water from the surface is contributing to their increasing prevalence. Additionally, they keep subterranean water from getting to the pavement's surface.

In situations where the costs of materials are prohibitively high in the area or where the necessary materials are not easily accessible, highway engineers can enhance the bearing capacity of the underlying soil by incorporating Portland cement, foamed asphalt, or novel technologies like cross-linking styrene acrylic polymer, which can boost the California Bearing Ratio of in-situ materials by a factor of 4–6.

7.3. BASE COURSE CONSTRUCTION

The area of the pavement portion directly beneath the surface course is known as the base course. The base course is built directly over this layer if there is a subbase course. If not, the subgrade is directly covered by the structure. Base course thickness typically varies between 4 and 6 inches, depending on the characteristics of the underlying layer.

Pavement surfaces are constantly subjected to heavy loads, most of which are absorbed by the base layer. Crushed stone, slag, or gravel are examples of untreated crushed aggregate that is typically used to build base courses. The base course material will be stable under the weight of building activity and have appropriate drainage properties.

The base course materials are frequently treated with fly ash, lime, calcium chloride, bitumen, or fly ash. These treatments act as a moisture barrier between the surface and foundation layers, improving support for large loads and susceptibility to frost.

7.4. SURFACE COURSE CONSTRUCTION

Hotmix asphalt and Portland cement concrete are the two types of pavement surfaces that are most frequently employed in the construction of highways. While carrying large traffic loads through the various base courses and into the underlying subgrade soils, these pavement surface courses also offer a safe and smooth riding surface.

7.5. HOT-MIX ASPHALT (HMA) LAYERS

Flexible pavements are surface courses made of hot-mix asphalt. Since its development in the late 1980s, the Super pave System has allowed for adjustments to material quality testing, requirements, mix design, and design methodology.

An experienced construction team dedicated to maintaining equipment control and work quality is necessary for the creation of an asphalt pavement that is durable and functional.

CONSTRUCTION ISSUES:

- Asphalt mix segregation
- Laydown
- Compaction
- Joints

Low viscosity asphalt is used as a prime layer on the base course before the HMA surface course is laid. Between the foundation course and the asphalt surface, this coat creates a cohesive layer by binding loose material.

A low viscosity asphalt emulsion called a tack coat is applied to a freshly laid asphalt overlay to establish a link between the two surfaces. Adjacent pavements (curbs) usually have tack coatings applied to them to help the HMA and concrete bind.

7.6. PORTLAND CEMENT CONCRETE (PCC)

Concrete surface courses made of Portland cement are sometimes known as firm pavements. Concrete pavements can be divided into three broad categories: jointed plain, jointed reinforced, and continuously reinforced.

Larger aggregates in the PCC mix interlock to transmit traffic loads across sections, or load transfer devices are incorporated into the surface's transverse joints. To effectively transfer loads across transverse joints while preserving the joint's horizontal and vertical alignment, dowel bars are employed as load-transferring devices. Deformed steel bars called tie-bars are positioned along longitudinal joints to keep neighbouring pavement sections aligned.

7.7. HIGHWAY MAINTENANCE

The major goals of highway maintenance are to correct flaws and maintain the structural integrity and usability of the pavement. Defining, comprehending, and documenting defects is necessary to choose the right maintenance schedule. Rigid and flexible pavements have different types of defects.

The four primary goals of maintaining highways are:

(1) Fixing functional problems in the pavement.
(2) Prolong the pavement's structural and functional service life.
(3) Preserve traffic safety and signs.
(4) Keep the road reserve in a suitable state.

7.8. PROJECT MANAGEMENT

Organizing and planning project activities from start to finish is called project management. Building infrastructure, such as roads and bridges, or doing significant and minor maintenance tasks associated with building infrastructure are examples of activities.

All associated operations and the project itself must be managed professionally, finished on schedule, and within budget. Additionally, effective project management depends on limiting negative effects on the environment and society.

8. CONCLUSIONS:

This project's primary goal was to compare the methods used in highway design. We completed a pavement design for introduction and a few methods of geometric design. We have completed both stiff and flexible pavement structures.

Roads are made to last for a specific amount of time. They require maintenance in order to increase their serviceability life and maintain the finest possible state for the road at all times. Mention that certain factors, such temperature or rainfall, must be considered when developing and maintaining the pavement structure based on the nation in which we are located. Thus, to develop a high-quality road, it may be necessary to spend significantly more money or do more upkeep on certain countries' roads.

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