

# TVET CERTIFICATE IV in Road Construction

**RCTRR401**

Road Layer Reconstruction

**Perform Road Layer Reconstruction**

*Competence*



**Credits: 4**

**Learning hours: 50**

**Sector: Construction**

**Sub-sector: Road Construction**

**Module Note Issue date:** August, 2020

## **Purpose statement**

This is a core module, which describes the performance outcomes, skills and knowledge required to prepare of bottom surface layer, placing of layers material according to the specifications and required application of flexible and rigid pavement techniques in accordance with distress types.

## Table of Contents

Elements of competence and performance criteria		Page No.
Learning Units	Performance Criteria	
1. Learning Unit1: Select materials ,tools, equipment and prepare workplace	1.1 Proper selection of materials according to the type of work.	5
	1.2 Proper selection of tools and equipment with respect to the work to be done	
	1.3 Convenient preparation of workplace according to the work to requirement	
2. Learning Unit 2: Reconstruct layers	2.1 Proper preparation of bottom surface layer as per specifications	18
	2.2 Proper placing of layers material according to the specifications	
	2.3 Adequate compaction of layer materials according to the specifications	
	2.4 Relevant application of flexible and rigid pavement techniques in accordance with distress types	
3. Learning Unit 3: Perform closing activities	3.1 Careful clearing of the work area in accordance with environmental impact assessment.	32
	3.2 Careful removal of ravage materials as per environmental impact assessment	
	3.3 Proper maintenance of tools and equipment in accordance with manufacturer recommendations	

Total Number of Pages: 38

## 0. INTRODUCTION

Road layer course is the layer directly in contact with traffic loads and generally contains superior quality materials. They are usually constructed with dense graded asphalt concrete(AC). The functions and requirements of this layer are:

- It provides characteristics such as friction, smoothness, drainage, etc. Also it will prevent the entrance of excessive quantities of surface water into the underlying base, sub-base and sub-grade,
- It must be tough to resist the distortion under traffic and provide a smooth and skid-resistant riding surface,
- It must be water proof to protect the entire base and sub-grade from the weakening effect of water.

### Binder course

This layer provides the bulk of the asphalt concrete structure. It's chief purpose is to distribute load to the base course The binder course generally consists of **aggregates** having less asphalt and doesn't require quality as high as the surface course, so replacing a part of the surface course by the binder course results in more economical design.

### Base course

The base course is the layer of material immediately beneath the surface of binder course and it provides additional load distribution and contributes to the sub-surface drainage It may be composed of **crushed stone, crushed slag, and other untreated or stabilized materials**.

### Sub-Base course

The sub-base course is the layer of material beneath the base course and the primary functions are to provide structural support, improve drainage, and reduce the intrusion of fines from the sub-grade in the pavement structure If the base course is open graded, then the sub-base course with more fines can serve as a filler between sub-grade and the base course A sub-base course is not always needed or used. For example, a pavement constructed over a high quality, stiff sub-grade may not need the additional features offered by a sub-base course. In such situations, sub-base course may not be provided.

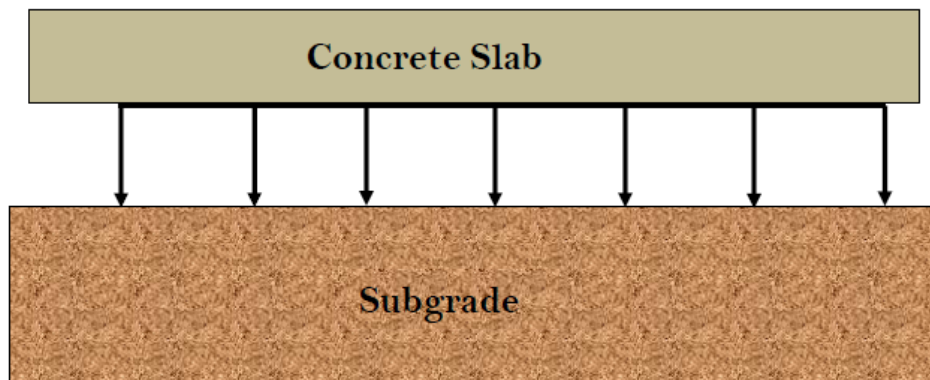
### Sub-grade

The top soil or sub-grade is a layer of **natural soil** prepared to receive the stresses from the layers above. It is essential that at no time soil sub-grade is overstressed. It should be compacted to the desirable density, near the optimum moisture content

### 0.1. RIGID (CONCRETE) PAVEMENTS or RIGID PAVEMENTS

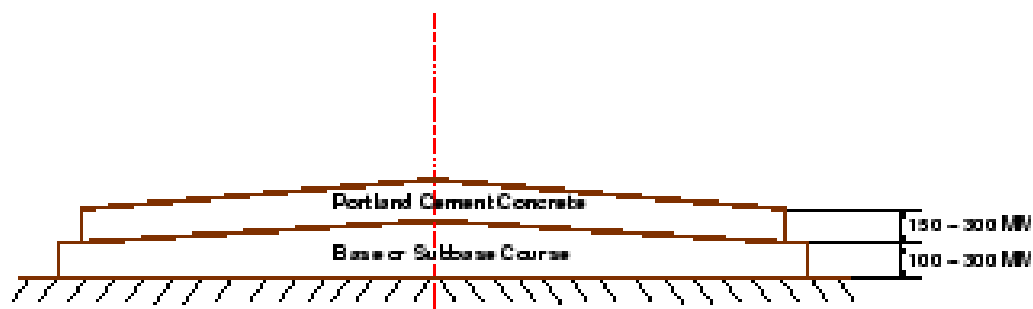
Rigid (Concrete) pavements are types of pavements composed on the top by cement concrete (slabs) in which the stresses are transmitted to the sub-grade through beam/ slab effect. Cement concrete has higher stiffness, which results in great loadspreadingcapacityandhenceinunderlyingpavementstructurelayers.

Thus in contrast with flexible pavements the depressions which occur beneath the rigid pavement are not reflected in their running surfaces.



#### 0.1.1. Typical layers of rigid pavement

Rigid pavements have sufficient flexural strength to transmit the wheel load stresses to a wider area below. A typical cross section of the rigid pavement is shown in Figure 1. Compared to flexible pavement, rigid pavements are placed either directly on the prepared sub-grade or on a single layer of granular or stabilized material. Since there is only one layer of material between the concrete and the sub-grade, this layer can be called as base or sub-base course.



**Figure 2:** Typical Cross section of Rigid pavement

In rigid pavement, load is distributed by the slab action, and the pavement behaves like an elastic plate resting on a viscous medium (Figure 2). Rigid pavements are constructed by **Portland cement concrete (PCC)** and should be analyzed by plate theory instead of layer theory, assuming an elastic plate resting on viscous foundation. Plate theory is a simplified version of layer theory that assumes the concrete slab as a medium thick plate which is plane before loading and to remain plane after loading. Bending of the slab due to wheel load and temperature variation and the resulting tensile and flexural stress.

## Learning Unit 1 – Select materials, tools, equipment and prepare workplace

### LO 1.1 – Select materials

#### ● Topic Description of materials used in reconstruction of road layers

1. **Cement:** A cement is a binder material, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete which are used in the base of road for providing strength and durability of road.
2. **Lime:** Is defined as binding material, Lime is used as an additive in asphalt which helps to improve the property of cohesion of road layer.
3. **Water:** used for mixing of concrete, watering and curing of road.
4. **Boards or timbers:** Used for formwork, supporting road channels during construction and also for the construction of road layer.
5. **Nails:** Are available in different sizes and are used to joint boards, timber, ceilings and profiles.
6. **Steel:** is a popular material used in the construction industry especially for building skyscrapers, bridges, tunnels, towers, industrial buildings and road barriers because of the properties they possess.
7. **Binding wire:** is used for the purpose of tying applications in the field of construction. It is used extensively in the construction sector for tying the rebars at the joints so as to keep the structure intact. Binding wire is also called annealed wire and is made of mild steel
8. **Aggregates:** Is a broad category of granular raw material of different sizes (sand, gravel, crushed stone, slag, recycled concrete etc) used in construction. Aggregate can be used in a number of ways in construction. In roads and railway ballast the aggregates are used to resist the overall load.
9. **Stones :** these are pieces of all classified of natural rocks which are finished as small building units for masonry and road construction, used in foundation bases, filling up on the floors as hardcore, and for fancing works.

10. **Bitumen** :is a black or dark colored (solid,semisolid,viscous)amorphous material that can be found in different forms such as rock asphalt ,natural bitumen,tar and bitumen derived from oil,which is refered to as petroleum bitumen .

## LO 1.2 – Select tools, and equipments

### Topic Description of tools and equipment used in road layers reconstruction

- **Pick axes** : Is the construction tool used for digging or excavating soil during road layer reconstruction .
- **Hoe/ Forked hoe**: Is the construction tool which is used for digging trenches or road layer during road construction.
- **Claw hammer** : Is the construction tool which Is used in fixing and pulling out of nails in the formworks.
- **Tape measures**: Is the flexible ruler used to measure size or distance during road layer reconstruction.
- **Topographic instruments**:Are surveying instrument used to measure the horizontal and vertical angles between points. Surveyors combine the angle data with distances from a chain or tape measure, and it allows them to triangulate the location of any point using trigonometry  
Example:Dump level,Theodolite
- **Wheelbarrow**:Is the construction equipment which is used for carrying construction materials.

### EXCAVATION EQUIPMENT

- **Grading equipment**: is the construction equipment which the work of ensuring a level base, or one with a specified slope, for a construction work such as a foundation, the base course for a road or a railway, or landscape and garden improvements, or surface drainage .



- **Paver machine:** is a piece of construction equipment used to lay asphalt on roads, bridges, parking lots and other such places. It lays the asphalt flat and provides minor compaction before it is compacted by a roller.



- **Compaction equipment:** is mechanically increasing the density of a soil or base material and force is the dead weight of the machine being used to apply a downward force compressing the particles below it. heavy duty machine that uses either a plate or roller mechanism to compact soil, asphalt, or concrete. These machines are necessary to prepare a construction job site before building a structure. The building's future structural integrity depends upon its resting on sturdy ground produced by the vibratory compactor.



- **Concrete mixer:** is a device that homogeneously combines cement, aggregate such as sand or gravel, and water to form concrete. A typical concrete mixer uses a revolving drum to mix the components. For smaller volume works, portable concrete mixers are often used so that the concrete can be made at the construction site, giving the workers ample time to use the concrete before it hardens. An alternative to a machine is mixing concrete by hand.





- **Loading machine:** are a type of heavy machinery used in construction, as well as for many other non construction tasks. They have sturdy tires equipped with large, rugged treads that allow for optimum maneuverability. Common types include mini, small, large and super wheel loaders; skid steers; front loaders and backhoe loaders.



- **Sprayer machine:** The machine which is used to spray or sprinkle bitumen or concrete on the surface in desired quantity is known as bitumen sprayer.



- **Cleaning machine:** Is the equipment used removing unwanted materials and road washing trucks at construction sites Road sweepers are widely used for keeping public roads, site roads, runways and other accesses clean and for suppressing dust.





- **Cutting machine:** are also known as milling machines, This type of construction equipment is used to remove asphalt and concrete from a surface. Inside these machines, a big drum rotates and grinds the surface accompanied by cutters that will cut the pavement.



- **Trucks:** Is an equipment for carrying goods and materials, usually consisting of a single self-propelled unit but also often composed of a trailer vehicle hauled by a tractor unit.



- **Concrete vibrator:** A vibratory compactor is a heavy duty machine that uses either a plate or roller mechanism to compact asphalt, or concrete and removing air void in the concrete for improving required durability and strength of concrete. Concrete vibrator used for road construction-based purposes.



- **Rock drill:** is a machine or a device that is specially designed to drill through rocks. This device can be used for certain activities like digging wells, preparing foundations, and mineral exploration.



- **Dumper:** This is used to transport the materials at the site and out of the site. Different types of dumpers are available at the market in different sizes.



## LO 1.3 – Prepare workplace

- **Topic: Description the preparation of workplace for road layer reconstruction**

### 1.3.1. Preparation of tools and equipment

Construction work is a hazardous land-based, Some construction site jobs include:, roads, tree forts, workplaces and repair and maintain infrastructures. This work includes many hazardous task and conditions such as working with height, excavation, noise, dust, power tools and equipment. The most common fatalities are caused by the fatal four: falls, being struck by an object, electrocutions, and being caught in between two objects. Due to the above hazards, the equipments and tools have to be checked, tested and assessed.

### 1. Testing of equipments

The equipments before being used must be tested for ensuring that they are in a good conditions for the work.

- Heavy machines must be tested by a competent person so as to ensure their working performance
- Temporarily adjustment and permanent adjustments must be done to the levelling instruments for the better performance

## **2.Assessment of tools**

Construction sites have a lot of sand and dust that gets into tools through any available opening causing bearing damage, forming conductive bridges that degrade tool operation, or acting as a sponge for humidity in the air. In a laboratory environment, blowers move very specific dust, gravel, and sand types all around the product in an enclosed chamber while measuring concentration, pressure, temperature, and humidity levels.

During shock testing, drop testers can angle and drop a product at specified angles and from various heights to test impact on corners and side to simulate shock impulses it will experience during shipping, loading, transport. It also reveals how resistant the tool is to being dropped or kicked, while vibration testing determines a tool's resistance to the hum of an engine and the movement of a truck bed or trailer during transport

Temperature and humidity chambers subject tools to extremes of heat, cold and moisture. Tools have to be able to function in the freezing cold of a Montana winter or the sticky heat of New Orleans in the summer. The testing makes sure the tools operate properly under these harsh conditions.

During chemical resistance testing, tools are sprayed with a variety of liquids they are likely to encounter on the job. Bombarding them with bleach, WD-40, gasoline, fertilizer, insecticides, degreasers, antifreeze and hydraulic fluid are all part of the testing regimen.

- Metal made tools must be lubricated with suitable oil to minimize the effects of corrosion
- They have to be checked in their handles for the breakage
- For those found in bad conditions, a quick repair must be done before their usage

### **1.3.2.Preparation of workplace**

#### **1.Demarcation of the working area**

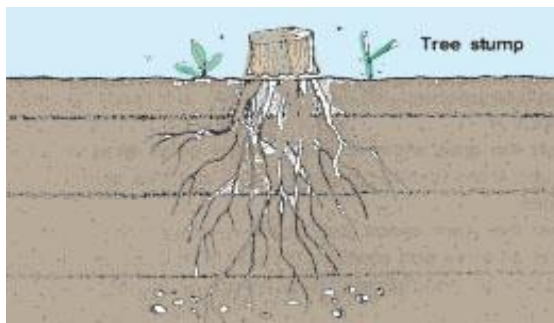
Site limits are set to define the useful area so as to avoid the misuse of the land

The construction site is usually prepared in two steps: first *the vegetation is cleared*, and then *the surface soil layer is removed*. These operations can be done either by hand or by machine. In both cases, special pieces of equipment such as ropes, cables and chains may be required. You will learn about these first, to be able to make the best and safest use of them.

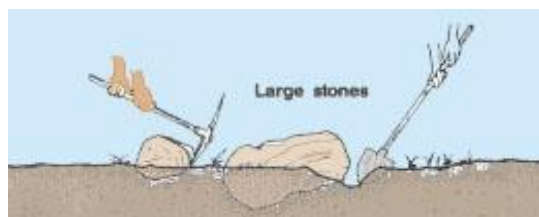
Clearing the site

1. The site should be cleared of all obstructions such as

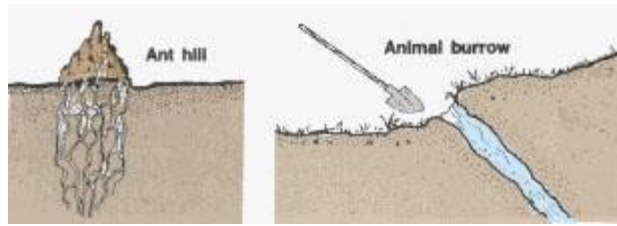
- Woody vegetation, where the roots can cause severe cracking in pond structures such as concrete water inlets and outlets
- Tree stumps which, when decaying, can also weaken concrete pond structures by leaving voids in the soil



- Large stones, which may need to be dug out;



- Ant hills and animal burrows, which should be dug completely; clayey soil should be tramped into the hole created



Where to clear

Define carefully the exact area to be cleared before you begin. Determine the outer corners of the pond area, which should include the entire area to be covered by the dikes. You could mark the area using wooden stakes and cord or poles. When this is done, mark out an additional area beyond the dikes to serve as a work space and a walkway around the site. Then you are ready to proceed.

(a) Clear the area within the limit of the pond dikes of all vegetation, shrubs, trees (including woody roots and tree stumps) and all large stones.

(b) Clear the work space and walkway around the dikes.

(c) Clear all trees and shrubs within 10 m of dikes and pond structures and any access, water supply or drainage area.

### **Surface soil removal**

Surface soil has the highest concentration of roots and decaying organic materials. This soil is unstable as a construction material and cannot be used for the foundations of any dike or structure. Therefore the surface soil should be removed from the areas where:

- Dikes and structures will be built;
- Soil will be taken as a dike construction material.

*The depth of the surface soil varies from region to region. It may be totally absent or more than 1m thick. Usually the surface soil is from 5 to 30 cm deep.* Once your site has been cleared, find out how thick the surface soil is. On this basis plan the construction method for your dikes and the removal and storage of the surface soil.

## **2. Addressing obstacles**

Various workplace safety signs commonly used at construction sites and industrial work

environments



Employees on construction sites also need to be aware of dangers on the ground. Cables running across roadways were often seen until cable ramp equipment was invented to protect hoses and other equipment which had to be laid out

Motor vehicle crashes are another major safety hazard on construction sites. It is important to be cautious while operating motor vehicles or equipment on the site. A motor vehicle should have a service brake system, emergency brake system, and a parking brake system. All vehicles must be equipped with an audible warning system if the operator chooses to use it. Vehicles must have windows and doors, power windshield wipers, and a clear view of site from the rear window. All employees should be properly trained before using motor vehicles and equipment.

- **Education and safety**

Construction workers need to be properly trained and educated on the task or job before working, which will assist in preventing injuries and deaths. There are many methods of training construction workers. One method is coaching construction site foremen to include safety in their daily verbal exchanges with workers to reduce work-related accidents. It is important that the workers use the same language to assure the best communication. In recent years, apart from traditional face to face safety knowledge sharing, mobile apps also make knowledge sharing possible.



Equipment on the job site must be properly maintained and inspected regularly before and after each shift. The equipment inspection system will help the operator make sure that a machine is mechanically sound and in safe operating conditions. An employee should be assigned to inspect equipment to insure proper safety. Equipment should have lights and reflectors if intended for night use. The glass in the cab of the equipment must be safety glass in some countries. The equipment must be used for its intended task at all times on the job site to insure workers' safety.

Each construction site should have a construction site manager. This is an occupational health and safety specialist who designs and implements safety regulations to minimize injuries and accidents. He or she also is in charge of conducting daily safety audits and inspections to ensure compliance with government regulations. Most construction site managers have an entry level experience or higher degree.

Before any excavation takes place, the contractor is responsible for notifying all applicable companies that excavation work is being performed. During excavation, the contractor is responsible for providing a safe work environment for employees and pedestrians.

- **Preventing accidents and improving safety**

Site preparation aids in preventing injury and death on construction sites. Site preparation includes removing debris, levelling the ground, filling holes, cutting tree roots, and marking gas, water, and electric pipelines. Another prevention method on the construction site is to provide a scaffold that is rigid and sufficient to carry its own weight plus four times the maximum intended load without settling or displacement

**Ways to prevent injuries and improve safety include:**

- ✓ Management safety
- ✓ Integrate safety as a part of the job
- ✓ Create accountability at all levels

- ✓ Take safety into account during the project planning process
- ✓ Make sure the contractors are pre-qualified for safety
- ✓ Make sure the workers are properly trained in appropriate areas
- ✓ Have a fall protection system
- ✓ Prevent and address substance abuse to employees
- ✓ Make safety a part of everyday conversation
- ✓ Review accidents and near misses, as well as regular inspections
- ✓ Innovative safety training, e.g. adoption of virtual reality in training
- ✓ Replace some of the works by robots (many workers may worry that this will decrease their employment rate)
- ✓ Adoption of BIM with three dimensional printing to make the building model first before put into real practical.

Operational Excellence Model to improve safety for construction organizations

There are 13 safety drivers associated with this model to improve safety for construction organizations:

1. Recognition & Reward
2. Employee Engagement
3. Subcontractor Management
4. Training & Competence
5. Risk Awareness, Management & Tolerance
6. Learning Organization
7. Human Performance
8. Transformational Leadership
9. Shared Values, Beliefs, and Assumptions
10. Strategic Safety Communication
11. Just & Fair Practices and Procedures
12. Worksite Organization
13. Owner's Role

Each safety driver mentioned above has some sub-elements attributed to it.

- **Personal protective equipment**

Hard hats and steel-toe boots are perhaps the most common personal protective equipment worn by construction workers around the world. A risk assessment may deem that other protective equipment is appropriate, such as gloves, goggles, or high-visibility clothing.

### **3.Positioning signs for safety measure**

Workers in highway work zones are exposed to a variety of hazards and face risk of injury and death from construction equipment as well as passing motor vehicles. Workers on foot are exposed to passing traffic, often at high speeds, while workers who operate construction vehicles are at risk of injury due to overturn, collision, or being caught in running equipment. Regardless of the task assigned, construction workers work in conditions in poor lighting, poor visibility, inclement weather, congested work areas, high volume traffic and speeds it better for positioning road signs for avoiding accidents.

## Learning Unit 2 – Reconstruct layers

### LO 2.1 – Prepare the bottom surface layer

#### Topic:Description the bottom surface layer for road

Subgrade is the bottom most layer which is nothing but natural soil layer compacted up to required depth generally about 150 to 300 mm to receive the loads coming from top layers. This layer is termed as foundation for the pavement system. A popular choice for the bottom layer is in the ranges size from one to two inches in diameter. Also called “clean stone,” this base gravel is made from machine-crushed stone and is composed of irregular rock fragments.

#### 2.1.1. Cleaning of bottom surface layer

The preparation of bottom surface layer consist of :

- **Cleaning of bottom surface layer**

The milling and removal of the destructed layer materials have taken away, the bottom surface layer must be cleaned off from impurities and organic matters to have a well preparation of the overlay materials

- **Leveling the bottom layer surface**

Once the cleaning action have been achieved, the next process consist of levelling and compacting the finished layer.

Grader machines In the construction of paved roads they are used to prepare the base course to create a wide flat surface by levelling the finished layer.

Motor graders are usually referred to as graders. These are heavy construction machines used to create smooth wide and levelled surfaces. The most traditional use of this particular construction machine is in construction and maintenance of roads with its main function being preparing the topmost layer for laying asphalt on top of it. In addition to its use in the road construction industry, internationally it is also used in removal of snow, debris and earthmoving based on the location and requirement. Motor graders come in after the heavy machines like the bulldozers are done with their job to give a finer finishing to the job.

The motor grader is usually a self propelled machine which comes with an adjustable blade. The blade is usually positioned between the front and rare axle and can be used for cutting, spreading and levelling jobs on a wide range of terrains. Some motor graders come with a

scarify option to scarify a layer and then remove it with the help of the blade. Then a new layer is spread before scarifying the top layer again to put in place.

Motor graders are generally classified based on the structure and arrangement of the frame. While history has seen motor graders of various sizes through the past few decades, a few set standard sizes have become set standard in the past few years. Based on frame arrangements the motor graders are classified into two categories

- Rigid Frame motor grader
- Articulated frame motor grader

**Rigid frame motor grader:** These usually have a single axle and are incapable of moving either left or right amount a point on the axle. This type of graders were popular in the 1980's and 90's.

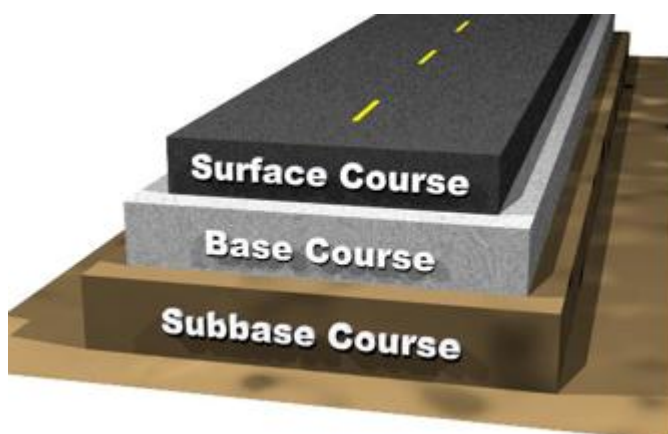
**Articulated frame motor graders:** These usually have both a front and rear axle. The blade is usually located somewhere between the two axles. The articulated frame graders are usually in small places where there is very less space to move and turn about in. Most machines manufactured and used these days are articulated frame graders, This really depends on a few things – weather, winter conditions, the weight of trucks using the surface, the thickness of the new layers, condition of the surface before construction, and how well it is taken care of post-construction. With that being said, reconstructed surfaces are expected to last anywhere from 15 to 25 years. Resurfacing surfaces can last 8 to 15 years

## LO 2.2 – Place layers material

- Topic Explanation the process of placing layers material for road

**Material layers** are usually arranged within a pavement structure in 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. A typical flexible pavement structure consists of:

- **Surface Course:** The layer in contact with traffic loads, It provides characteristics such as friction, smoothness, noise control, rut resistance and drainage. It prevents entrance of surface water into the underlying, This top structural layer of material is sometimes Surface courses are most often constructed out of HMA.
- **Base Course:** The layer immediately beneath the surface course, It provides additional load distribution and contributes to drainage. Base courses are usually constructed of crushed aggregate or crushed stone.
- **Subbase Course:** The layer between the base course and subgrade, It functions primarily as structural support but it can also minimize the intrusion of fines from the subgrade into the pavement structure and improve drainage of road. The subbase generally consists of lower quality materials than the base course but better than the subgrade soils. A subbase course is not always needed or used. Subbase courses are generally constructed out of crushed aggregate or engineered fill.



### **Dumping layers material process**

- Placing of layer materials: The placement of layers materials for road must be occur based on the materials provided which improving strength and durability of layers
- Estimate the spacing distance: The spacing between layers providing the movement of road and drainage.

## **LO 2.3 – Compact layer materials**

### **• Topic Explanation the compaction of road layers material for road**

#### **2.3.1. Compaction degree**

Layer compaction is the process by which soil particles are packed more closely together by dynamic loading such as rolling, tamping or vibration it is achieved through the reduction of air voids with little or no change in water content of soil for road layers. Compaction is achieved by reduction in the volume of air, as solid and water are virtually incompressible and increase the bearing capacity of road.

There are several means of achieving compaction of a material. Some are more appropriate for soil compaction than others, while some techniques are only suitable for particular soils or soils in particular conditions. Some are more suited to compaction of non-soil materials such as asphalt. Generally, those that can apply significant amounts of shear as well as compressive stress, are most effective.

Compaction is required for the following reasons:

- ✓ Compaction improves the engineering properties like shear strength, density, permeability etc. of the fill.
- ✓ It reduces the potential for excessive settlement.
- ✓ It reduces the chances of slope stability problems like landslides.
- ✓ It reduces the amount of water that can be held in the soil by decreasing the void ratio and thus helps in maintaining the required strength.
- ✓ It increases the erosion resistance which helps in maintaining the ground surface in serviceable condition



Different types of rollers are most suitable for layer's compaction for maintaining a strong and levelled surface

Depending upon the project requirement and soil to be compacted, different types of rollers are used for compaction work. The various types of rollers which are used for compaction are:

1. Cylindrical Rollers
2. Sheeps foot Rollers
3. Pneumatic tyred Rollers
4. Smooth wheeled Rollers
5. Vibratory Rollers
6. Grid Rollers

#### **Compaction of bottom layer surface process**

- Succession of compaction machines
- Monitor pass of rolling and
- vibrating according to the load of machines

#### **LO 2.4 – Apply flexible and rigid pavement techniques**

- **Topic:Description rigid and flexible pavement techniques**

#### **Difference between Flexible Pavements and Rigid Pavements**

Sl. No.	Flexible Pavement	Rigid Pavement
1.	It consists of a series of layers with the highest quality materials at or near the surface of pavement.	It consists of one layer Portland cement concrete slab or relatively high flexural strength.
2.	It reflects the deformations of subgrade and subsequent layers on the surface.	It is able to bridge over localized failures and area of inadequate support.
3.	Its stability depends upon the aggregate interlock, particle friction and cohesion.	Its structural strength is provided by the pavement slab itself by its beam action.

4.	Pavement design is greatly influenced by the subgrade strength.	Flexural strength of concrete is a major factor for design.
5.	It functions by a way of load distribution through the component layers	It distributes load over a wide area of subgrade because of its rigidity and high modulus of elasticity.
6.	Temperature variations due to change in atmospheric conditions do not produce stresses in flexible pavements.	Temperature changes induce heavy stresses in rigid pavements.
7.	Flexible pavements have self healing properties due to heavier wheel loads are recoverable due to some extent.	Any excessive deformations occurring due to heavier wheel loads are not recoverable, i.e. settlements are permanent.

#### **2.4.1.Flexible pavement techniques**

##### **1) Slurry seals**

A slurry seal is the application of a mixture of water, asphalt emulsion, aggregate (very small crushed rock), and additives to an existing asphalt pavement surface. A slurry seal is similar to a fog seal except the slurry seal has aggregates as part of the mixture. This combined mixture of the emulsion and aggregates represents “slurry.” Polymer is commonly added to the asphalt emulsion to provide better mixture properties. The placement of this mixture on existing pavement is the “seal” as it is intended to seal the pavement surface. Slurry seals are generally used on residential streets

Slurry seal is applied in order to help preserve and protect the underlying pavement structure and provide a new driving surface. Roads chosen for slurry seal applications generally have low to moderate distress and narrow crack width. Slurry seal applications serve to seal the cracks, restore lost flexibility to the pavement surface, provide a deep, rich black pavement surface color, and help preserve the underlying pavement structure

Location, weather, traffic loading, and pavement conditions are factors used to determine

if a slurry seal application is appropriate. Roadways selected for slurry seal treatment are commonly those which have slight to moderate distress, no rutting, and generally narrow crack widths, and where a slurry seal treatment would help extend the pavement life until resurfacing becomes necessary.

Roadways chosen for cyclical slurry seal applications would typically be treated every five to seven years

## **2) Bituminous surface treatments**

Before a pavement is placed the surface to be paved must be prepared. Adequate surface preparation is essential to long-term pavement performance. Pavements constructed without adequate surface preparation may not meet smoothness specifications, may not bond to the existing pavement (in the case of overlays) or may fail because of inadequate subgrade support

Surface preparation generally takes one of two forms:

- ✓ Preparing the subgrade and granular base course for new pavement.  
This can involve such activities as subgrade stabilization, over-excavation of poor subgrade, applying a prime coat or compacting the subgrade.
- ✓ Preparing an existing pavement surface for overlay. This can involved such activities as replacing localized areas of extreme damage, applying a leveling course, milling, applying a tack coat, rubblizing or cracking and seating an underlying rigid pavement, and replacing localized areas of extreme damage.

After final grading (often called fine-grading), the subgrade elevation should generally conform closely to construction plan subgrade elevation. Large elevation discrepancies should not be compensated for by varying pavement or base thickness because (1) HMA, and aggregate are more expensive than subgrade and (2) HMA compacts differentially – thicker areas compact more than thinner areas, which will result in the subgrade elevation discrepancies affecting final pavement smoothness.

### **3) Crack Seals**

Crack seal products are used to fill individual pavement cracks to prevent entry of water or other non-compressible substances such as sand, dirt, rocks or weeds. Crack sealant is typically used on early stage longitudinal cracks, transverse cracks, reflection cracks and block cracks. Fatigue cracks are most often too extensive to warrant filling with crack sealer; they usually require an area treatment such as a patch or reconstruction. Crack filler material is typically some form of rubberized asphalt or sand slurry

#### **❖ Purpose of crack seals**

Preventive maintenance. Crack filling to prevent entry of water or other non-compressible substances into the pavement.

#### **❖ Materials of crack seals**

Heated liquid asphalt (often some form of rubberized asphalt).

### **4) Structural / Non structural overlay**

Non-structural overlays /structural overlay do not involve extensive structural design and generally contribute little, if anything, to a pavement's structural capacity. Non-structural overlays are generally thin surface overlays that are used to :

- Improve ride quality.
- Correct minor surface defects.
- Improve safety characteristics such as skid resistance and drainage.
- Enhance appearance.
- Reduce road-tire noise.

Non-structural overlays can vary widely in composition depending upon local practice, traffic and general purpose. A loose classification of non-structural overlays follows:

- ✓ Light volume/residential traffic. The primary objective in light traffic areas is to retard asphalt binder aging of the underlying pavement. Since heavy traffic loads are not of great concern, overlays are generally less stiff (resulting in a more workable mix, increased durability and flexibility and a potential for the overlay to reheal under traffic) and use smaller- sized aggregates.
- ✓ Heavy, high-speed traffic. The primary objective in heavy, high-speed traffic areas is to prevent rutting and provide good friction. Because of this, overlays typically use larger angular aggregate and more durable mixes such as SMA or OGFC.

### **5) Fog Seals**

A fog seal is a light application of a diluted slow-setting asphalt emulsion to the surface of an aged (oxidized) pavement surface. Fog seals are low-cost and are used to restore flexibility to an existing HMA pavement surface. They may be able to temporarily postpone the need for a surface treatment or non-structural overlay.

#### **❖ Purpose of Fog Seals**

Preventive maintenance. Fog seals are used to restore or rejuvenate an HMA surface. They may be able to postpone the need for a BST or non-structural overlay for a year or two.

#### **❖ Materials of Fog Seals**

Slow-setting asphalt emulsion

#### **❖ Mix Design of Fog Seals**

None beyond the manufacturer's. A test patch may be needed to determine the proper application rate

### **6) Repainting of marking**

Road surface marking is any kind of device or material that is used on a road surface in order to convey official information; they are commonly placed with road marking machines (or road marking equipment, pavement marking equipment). They can also be

applied in other facilities used by vehicles to mark parking spaces or designate areas for other uses.

Road surface markings are used on paved roadways to provide guidance and information to drivers and pedestrians. Uniformity of the markings is an important factor in minimizing confusion and uncertainty about their meaning, and efforts exist to standardize such markings across borders. However, countries and areas categorize and specify road surface markings in different ways — white lines are called white lines mechanical, non-mechanical, or temporary. They can be used to delineate traffic lanes, inform motorists and pedestrians or serve as noise generators when run across a road, or attempt to wake a sleeping driver when installed in the shoulders of a road. Road surface marking can also indicate regulation for parking and stopping.

#### **2.4.2. Rigid pavement techniques**

The process of the below layers are the same as in flexible pavement from subgrade to base course hence concreting takes place

##### **I. PCC Joint and Crack Sealing**

Sealant products are used to fill joints and cracks in order to prevent entry of water or other non-compressible substances. Although most PCC pavement joints are sealed at the time of new construction, the useful sealant life is limited as stated by the ACPA on their web site:

“A typical hot-pour sealant provides an average of 3 to 5 years of life after proper installation. Some low-modulus or PVC coal-tars can perform well past

8 years. Silicone sealants have performed well for periods exceeding 8 to 10 years on roadways. This type of performance hinges on joint preparation and installation. Of extreme importance is that the joint be clean and dry. Compression seals provide service for periods often exceeding 15 years and sometimes 20 years.”

Crack sealant is typically used on early stage, isolated panel cracks; extensive or advanced panel cracking is a symptom of larger problem (e.g., lack of panel support, inadequate structural design or poor construction) that cannot be addressed by simple crack sealing.

##### **❖ Purpose of PCC Joint and Crack Sealing**

Preventive maintenance. Joint and crack filling to prevent entry of water or other non-

compressible substances into the pavement.

## **II. Diamond grinding**

Diamond Grinding (PCC pavements). A thin top layer can be milled off of an existing pavement to smooth out relatively small surface distortions prior to rigid overlay.

Although typically used for rigid pavement surface restoration, diamond grinding can be used to eliminate relatively small surface distortions in existing rigid pavement prior to flexible or rigid overlays. Because it roughens the existing rigid pavement surface, diamond grinding also improves the bond between the existing pavement and the overlay. Non-overlay applications of diamond grinding are covered in Diamond Grinding.

Diamond grinding is a pavement preservation technique that corrects a variety of surface imperfections on both concrete and asphalt pavements. Most often utilized on concrete pavement, diamond grinding is typically performed in conjunction with other concrete pavement preservation (CPP) techniques such as road slab stabilization, full- and partial-depth repair, dowel bar retrofit, cross stitching longitudinal cracks or joints and joint and crack resealing. Diamond grinding restores readability by removing surface irregularities caused during construction or through repeated traffic loading over time. The immediate effect of diamond grinding is a significant improvement in the smoothness of a pavement. Another important effect of diamond grinding is the considerable increase in surface macrotexture and consequent improvement in skid resistance, noise reduction and safety

### **❖ Process of Diamond grinding**

Results of diamond grinding of pavement

Diamond grinding involves removing a thin layer at the surface of hardened PCC using closely spaced diamond saw blades. The level surface is achieved by running the



blade assembly at a predetermined level across the pavement surface, which produces saw cut grooves. The uncut concrete between each saw cut breaks off more or less at a constant level above the saw cut grooves, leaving a level surface (at a macroscopic level) with longitudinal texture. The result is a pavement that is smooth, safe, quiet and pleasing to travel.

The diamond blades are composed of industrial diamonds and metallurgical powder. When grinding materials contain hard aggregate materials, a diamond blade with a soft bond is needed, which means that the metallurgical powders in the cutting segments of the blade wear fast enough to expose the diamond cutting media at the proper rate for efficient cutting. Conversely, to cut soft aggregates, a diamond blade with a hard bond is recommended.

Diamond grinding should not be confused with milling or scarifying. Milling is an impact process that chips small pieces of concrete from the pavement surface. Diamond grinding is a cutting process.

For grinding asphalt to remove old pavement, see pavement milling.

### **❖ Applications of Diamond grinding**

There are many surface issues that diamond grinding can improve or correct. Some of the surface imperfections that can be addressed by diamond grinding include: faulting at joints and cracks, built-in or construction roughness, polished concrete surfaces exhibiting inadequate macrotexture, wheel path rutting caused by studded tires, unacceptable noise level, slab warping caused by moisture gradient and construction curling, inadequate transverse slope and splash and spray reduction

### **III. Slab stabilization**

Slab stabilization seeks to fill voids beneath the slab caused by pumping, consolidation or other means. If left untreated, these voids, which are often quite small, may cause other

problems such as faulting, corner breaks or cracking . Voids are typically filled by pumping grout through holes drilled through the slab.

#### ❖ **Purpose of Slab stabilization**

Preventive and corrective maintenance. Restores proper base/subgrade slab support to prevent more serious distresses such as faulting, corner breaks and cracking.

#### ❖ **Materials of Slab stabilization**

Pozzolan,-cement grout.

#### ❖ **Other Information about Slab stabilization**

Slab stabilization only fills the voids under a slab, it should not be confused with slab jacking, which is used to raise the elevation of a depressed slab

### **IV. Joint Repair**

In PCC pavements, joints are provided to accommodate concrete volume changes due to temperature and moisture variations. Additionally, transverse construction joints are installed as a terminus following the end of production or abutment to existing pavement. In concrete pavement contraction design (CPCD), both transverse and longitudinal joints are used. These joints relieve stresses in concrete, thereby preventing or minimizing the potential for uncontrolled cracks. The concrete movement at the joints could be substantial, and joint sealants are provided to seal and protect the joints from the infiltration of water and incompressible foreign materials.

Joints are one of the weakest areas in PCC pavement. There is a discontinuity in concrete at saw cut joints and wheel loads are not transferred 100 % from one slab to the next, resulting in higher wheel load stress. When incompressible materials get into the joints, expansion of concrete slabs due to high ambient temperatures will squeeze the incompressible materials and high localized stresses will develop in the

concrete. Localized high concrete stresses can cause spalling in the joints. Also, if a good joint seal is not maintained, water and de-icing compounds can get into the joint and cause corrosion problems in dowel bars

At the transverse joints in CPCD, dowel bars are used to improve load transfer efficiency (LTE) over simple aggregate interlock. The higher the LTE, the lower the wheel load stress, and the better the pavement performance. For dowel bars to perform as they are intended, their alignment should be parallel to the direction of concrete movement, both horizontally and vertically. If dowel bars are mis-aligned, high stress concentration and cracking will result in the concrete slab.

❖ Pavement distresses that require joint repairs

In CPCD any cracking, breaking, or spalling of slab edges on either side of transverse joints need to be repaired. The repair can be FDR or PDR, depending on the extent of the breaking or spalling. If the distress extends through the depth of the slab or hinders the ability of dowel bars to transfer load, FDR is required

In CRCP, failures in transverse construction joints require joint repairs. Additional longitudinal steel is used at the transverse construction joints to accommodate large concrete stresses, which requires special attention for proper concrete consolidation under the longitudinal steel. If proper consolidation is not provided at these transverse joints, delamination and distress can result. Any repair of the transverse construction joints requires FDR.

In establishing boundaries of joint repairs in CPCD, if the patch boundary falls within 6-ft of an existing undoweled transverse joint that does not require repair, extend the patch to the transverse joint. If the boundary falls on an existing doweled transverse joint, and the other side of the joint does not require repair, extend the patch beyond the transverse joint by about 1-ft to remove the existing dowels.

## Learning Unit 3 – Perform Closing Activities

### LO 3.1 – Clear the work area Clean

- **Topic 1 Description of environmental impact assessment**

#### 3.1.1. Environmental impact assessment

Environmental impacts are the effects got from the surrounding. They may be positive impacts or negative impacts according to the way it is treated within positive impacts, we may get the oxygen, the rain and so on.while the negative impacts that we can say is excessive sunshine, thunder and so on.When cleaning the area, consider the way you will protect the environment with the wastes that you are cleaning on the area because the may cause some of negative impacts like pollution of our atmosphere, pollution of water bodies,

#### 3.1.2.general safety rules

These are rules that are set up to prevent negative impacts during clearing work  
Wear the PPE while clearing the area do not dispose the wastes in rivers pour water where you are going to clean so as to prevent our atmosphere with dusts treat wastes before stacking them avoid throwing toxic substances on the ground protect your body when clearing the area

- **Clearing method**

Cleaning workplace that involves removing tree roots and other organic matters from construction site. This is very important as tree roots and other organic matters can cause the future settling of earth which will cause for your structure damage.

- a. **By hand:** here the workplace is cleared using hand tools like hoes, spades and brushes
- b. **By Machine:** the use of air compressors for removing dusts and graders for cleaning off top grasses and other clearing equipments

## LO 3.2 – Remove ravage materials

- Topic:Description the types of wastes

**1. Biodegradable waste** includes any organic matter in waste which can be broken down into carbon dioxide, water, methane or simple organic molecules by micro-organisms and other living things using composting, aerobic digestion, anaerobic digestion or similar processes. In waste management, it also includes some inorganic materials which can be decomposed by bacteria. Such materials include gypsum and its products such as plasterboard and other simple organic sulfates which can be decomposed to yield hydrogen sulfide in anaerobic land- fill conditions

### **Uses of biodegradable waste**

Biodegradable waste can be used for composting or a resource for heat, electricity and fuel by means of incineration or anaerobic digestion. Swiss Kompogas and the Danish AIKAN process are examples of anaerobic digestion of biodegradable waste. While incineration can recover the most energy, anaerobic digestion plants retain the nutrients and compost for the soil and still recover some of the contained energy in the form of biogas. Kompogas produced 27 million Kwh of electricity and biogas in 2009. The oldest of the company's own lorries has achieved 1,000,000 kilometers driven with biogas from household waste in the last 15 years.

**2. Chemical waste** is a waste that is made from harmful chemicals (mostly produced by large factories). Chemical waste may fall under regulations such as COSHH in the United Kingdom, or the Clean Water Act and Resource Conservation and Recovery Act in the United States. In the U.S., the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA), as well as state and local regulations also regulate chemical use and disposal. Chemical waste may or may not be classed as hazardous waste. A chemical hazardous waste is a solid, liquid, or gaseous material that displays either a

“Hazardous Characteristic” or is specifically “listed” by name as a hazardous waste. There are four characteristics chemical wastes may have to be considered as hazardous. These are Ignitability, Corrosivity, Reactivity, and Toxicity. This type of hazardous waste must be categorized as to its identity, constituents, and hazards so that it may be safely handled and managed. Chemical waste is a broad term and encompasses many types of materials.

**3. Demolition waste** is waste debris from destruction of buildings, roads, bridges, or other structures. Debris varies in composition, but the major components, by weight, in the US include concrete, wood products, asphalt shingles, brick and clay tile, steel, and drywall. There is the potential to recycle many elements of demolition waste.

**4. Industrial waste** is the waste produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as that of factories, industries, mills, and mining operations. It has existed since the start of the Industrial Revolution. Some examples of industrial wastes are chemical solvents, pigments, sludge, metals, ash, paints, sandpaper, paper products, industrial by-products, metals, and radioactive wastes.

Toxic waste, chemical waste, industrial solid waste and municipal solid waste are designations of industrial wastes. Sewage treatment plants can treat some industrial wastes, i.e. those consisting of conventional pollutants such as biochemical oxygen demand (BOD). Industrial wastes containing toxic pollutants require specialized treatment systems.

**5. Electronic waste or e-waste** describes discarded electrical or electronic devices. Used electronics which are destined for reuse, resale, salvage, recycling, or disposal are also considered e-waste. Informal processing of e-waste in developing countries can lead to adverse human health effects and environmental pollution. Electronic scrap components, such as CPUs, contain potentially harmful components such as lead, cadmium, beryllium, or brominated flame retardants. Recycling and disposal of e-waste may involve significant risk to health of workers and communities in developed countries and great care must be taken to avoid unsafe exposure in recycling operations and leaking of materials such as heavy metals from landfills and incinerator ashes.

## **6. Recycling of demolition wastes**

### **A. Concrete and Brick recycling**

Concrete and brick can be recycled by crushing it into rubble. Once sorted, screened and contaminants are removed, reclaimed concrete or brick can be used in concrete aggregate, fill, road base, or riprap. Mobile concrete crushers also allow for recycling of concrete on-site.

### **B. Wood/Timber recycling**

Wood can be reused, repurposed, recycled, or burned as bioenergy. Reused wood to eliminate the need for full-size new lumber if used for smaller building components. Repurposed or recycled wood can be used in pathways, coverings, mulches, compost, animal bedding, or particleboard.

### **C. Drywall recycling**

Drywall is made primarily of gypsum. Once the gypsum is depapered, it can be added in cement production, as a soil amendment, used in aerated composting, or recycled into new drywall. Gypsum recycling can be particularly beneficial because in landfill conditions gypsum will release hydrogen sulfide, a toxic gas.

### **D. Asphalt recycling**

Asphalt, from shingles or asphalt concrete, is typically recycled and used in pavement.

### **E. Metal/Scrap recycling**

Scrap metal is an established industry focused on the collection, buying, selling, and recycling of salvaged materials.



## **LO 3.3 – Maintain tools and equipment**

### **Topic 1:Description the cleaning methods and Storing the tools and equipment**

The tools and equipments which have been used in performance of construction activities must be cleaned before being kept in their appropriate place.

Two methods of cleaning exists:

1. Manual cleaning method: this is the method of clearing the area using hand tools like spade or hoe.
2. Mechanical cleaning

#### **Maintain tools and equipment**

During activities some of tools and equipments may be damaged hence they need to be maintained and repaired for the future use. The destroyed parts must be replaced by a competent person

#### **Storing the tools and equipment**

To avoid the tools and equipments to be stolen or to be damaged by external weathering , stores must be present whereby they have to be stored .

The tools are stored in shelves according to their types. And the similar types are stored together to avoid their shortage

Semi Heavy Equipments are stored where they can't disturb movements in the store.

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