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Ministry of Labor and Skills

Road Construction and Maintenance - Level-III

Based on September 2023, Curriculum Version II

Module Tittle: Asphalt Concrete Production

Module code: EIS RCM3 08 0923

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Prepared by: Ministry of Labor and Skill

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Bridges to Prosperity

HELVETAS Swiss Intercooperation ETHIOPIA

Contents

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Acronyms

AC	Asphalt concert
ASTTO	American Standard for Testing Material
ASTM	American Standard for Testing Material
EBCS	Ethiopian Building Code Standard
ERA	Ethiopian Road Authority (Currently: Ethiopian Road Administration)
LAP	Learning Activity Performance
LG	Learning Guide
M	Module
OS	Occupational Standard
OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
PC	Pre-mix concrete
RHC	Research against cancellation
RCM	Road Construction and Maintenance
TTLM	Teaching, Training and Learning Materials

Introduction to the module

This Module covers the conducting and monitoring of asphalt concrete production activities in the road construction. It includes planning and preparing for operation, allocating and logging resources, conduct the production operation, monitoring and reporting plant/machinery activity, and monitoring movement of materials.

The Module sets out the requirements for the production of asphalt for roads and related applications. It sets the minimum requirements for:

- Evidence of compliance, records, sampling and testing frequencies during production.
- Properties of materials to be used in asphalt production.
- Mix design.
- Process control in manufacture.

Module units

- Plan and preparation for asphalt concrete.
- Allocate and log resources
- Monitor and report plant/ machine activity
- Monitor and report operational activities
- Monitor movement of materials

Learning objectives of the module

At the end of this session, the students will able to:

- Introduce plan preparation for operation
- Understanding how to allocate and log resources
- Explain plant/ machine activity
- Monitor and report operational activities.
- Identify movement of materials

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Unit one: Plan and prepare for operation asphalt concrete

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Relevance Documents
- Safety Requirements
- Plant, Tools And Equipment
- Shifting Changeover Details and Communications
- Potential Risks, Hazards and Environmental Issues
- Application of Computer Systems to recording Maintenance Defects.

This guide will also assist you to attain the learning outcomes stated in the cover page.
Specifically, upon completion of this learning guide, you will be able to:

- Over view of plan and preparation asphalt concrete
- Apply Relevance documents
- apply safety requirements
- Selecting plant, tools and equipment.
- Explain coordinating shift activities with other
- Identify Potential risks, hazards on environmental issues
- Use computer systems and equipment's to recording maintenance defects.

1.1. Compliance documents

Asphalt is a mixture of aggregate binder and filler used for constructing and maintaining all kind of road parking area. Aggregate used for asphalt mix could be crushed rock, sand , gravel, and etc. in order to bind aggregates in to cohesive mixture a binder used most commonly bitumen used as a binder an average asphalt pavement consist of the road structure above the formation level.

Asphalt is mainly used for paving roads it can also use for other various purposes:

- Transportation (roads)
- Railway (beds) or
- Building construction (floors)

Asphalt can be produce in a fixed plant machine. Asphalt plant machine can produce more than 800 tones per hour. Average production temperature 150 ^{0} C- 190 ^{0} C which depends on the mixture produced material.

The above types of explanation need evidence from compliance documents. Compliance documents used to provide evidences and successfully implement their compliance program to agencies to show that adhering to the required laws and regulation

Relevant documentation

Relevant documentation is information including records, reports, observations and verbal responses required to verify compliance with standards by a facility or program. The purpose of documentation is to outline the process for work health and safety (WHS) document control and record management at the related legislative system requirement for the success of work safety management system allowing for consistency and uniformity applying health and safety in the work place. Typical documents also include plans, polices, procedures, guidelines and forms that define the system.

Procedures

Electronic format:-all documentation that is used or introduced to the safety and wellbeing website forms part of the work safety management system.

Document creation: - the requirement or need for new or additional documentation to be introduce to the safety and management system. The requirement and system may be based on:

- **Legislation** : Ethiopian Roads Authority (ERA) Pavement Design Manual Volume I Flexible Pavements(2013)
- Work cover code of conduct and performance standards for self-insures.
- Organization and site requirements and procedures
- Manufacturer’s guidelines specifications and standards
- Acts and regulations dealing with worksite safety and health
- Worksite inspection

- OHS Explosives Employment and workplace relations legislation
- Equal Employment Opportunity and Disability Discrimination legislation

Document review: - Any controlled system documentation requires regular review process includes consideration of the following:

- Suitability and relevance to the work place
- Identify areas requiring improvement
- Effectiveness in achieving desired outcomes
- Corrective action is required

Document format: - the following standard format is applicable to all WHS procedures**:**

- Title
- Purpose
- Definition
- Roles and responsibility
- Procedural content
- Performance measures
- References

1.2. Safety requirements

1.2.1. Occupational Safety and Health (OHS)

Safety is always a consideration when working with hot materials. Conventional AC mixtures are hot enough to cause burns, and so are asphalt rubber binders and Reservation against cancellation (RAC) materials.

- OHS requirements in accordance with state or territory legislation and regulations, organizational safety policies and procedures, and project safety plan, including protective clothing and equipment, use of tools and equipment, workplace environment and safety, handling of materials, use of firefighting equipment, use of First Aid equipment, hazard control and hazardous materials and substances.
- Safe operating procedures including recognising and preventing hazards associated with moving machinery, flammable, toxic and dangerous materials, personnel, working in proximity to others, worksite visitors and the public
- Always use protective clothing when operating spray equipment, i.e. gloves, boots and overalls.
- Use a flint gun and not matches to light the burner.
- Make sure all valves are closed on the gas cylinder when finished spraying.

- Store the gas cylinder in a safe place on completion of spraying.
- Do not use diesel for cleaning spray equipment or hands.
- safe parking practices including ensuring access ways are clear, Equipment/machinery is away from overhangs and refueling sites, safe distance are kept from
- Emergency procedures related to equipment operation including emergency shutdown and stopping, Extinguishing equipment fires, organizational first aid requirements and evacuation site include: car parks, airport rail ways, container yards, hard stands, footpaths, roadways and so on.

Figure 1-1 Site safety notice

1.2.2. Safety Equipment Checklist

Should have:

- A hard hat
- A reflective safety vest
- Emergency phone numbers.
- Knowledge of Contractor's Job Safety Program and any required training.
- Informed the Contractor's on site supervisor of your presence before moving about the plant or equipment.

When working around hot asphalt (e.g. at plants and distributors), you should have:

- Heavy gloves
- Heavy, long-sleeved shirt or jacket
- Eye protection (goggles)

Vehicle should have:

- A first aid kit
- A fire extinguisher
- Strobe light
- At airports, a radio for communications.

Should know:

- Where the nearest hospital, clinic or ambulance service is located
- Who on the job site has had first aid training?

Furthermore, goggles and a respirator are recommended where dust or flying rock may be a problem (e.g. near crushers). Noise protection may be needed around crushers and other noisy equipment. Permanent hearing loss takes only minutes at high noise levels.

To prevent overexposure to hydrogen sulfide and other fumes, follow these guidelines:

- Keep your face at least two feet away from asphalt tank hatch openings.
- Stay upwind of open hatches.
- Avoid breathing fumes when opening hatches or taking samples

In case of overexposure to fumes, do the following:

- Move the victim immediately to fresh air.
- Administer oxygen if breathing is difficult.
- Start artificial respiration if breathing stops.
- Have the victim examined by a physician immediately.

1.3. Plant, tools and equipment

Asphalt Concrete Production applies to the construction of asphalt concrete pavement on a prepared surface according to the contract, Include pavement wearing course mixture and a binder course mixture when specified herein.

All materials used in the production of asphalt shall have consistent properties and shall satisfy the requirements of the specification. The plant mixed asphalt concrete includes a mixture of aggregate, filler or blending sand, if acceptable, and asphalt cement. Size, uniformly grade, and combine aggregates so that the resulting mixture meets the grading requirements of the job-mix formula. Each individual component of the supplied mix shall be obtained from the same source as the materials used to establish the job Mix.

Materials used in the production of asphalt concretes are:

- Asphalt Cement

- Emulsified Asphalt
- Aggregate for Hot Plant Mix Bituminous Pavement
- Filler
- Blending Sand
- Hydrated Lime

1.3.1. Types of asphalt mixing plant

According to different classification standards, asphalt mixing plants can be divided into different types. For example, according to mobility, it can be divided into stationary (fixed) type and mobile type; according to different mixing methods, it can be divided into continuous drum mixing type and intermittent forced mixing type; according to different production capacity, it can be divided into small, medium and large asphalt plants.

In fact, there are three common types of asphalt mixing plants

i) Forced (batch) mix asphalt plant
ii) Drum mix plant and
iii) Mobile asphalt plant.

Fixed type

i) Forced (batch) mix asphalt plant

As the name implies, the forced mixing asphalt plant is a kind of equipment that uses a forced mixer to mix asphalt mixture. It is also called asphalt batch mix plant. It is mainly suitable for projects with high requirements on project quality and output, such as municipal roads, graded roads, airport roads,

Requirements for Batching Plants

Basic requirements for batching plants are: Weigh Box or Hopper, Asphalt Cement Control, Mixer and Control of Mixing Time etc.

Automated Plants: Modern batch plants fall also in to three categories, depending on the degree of automation:

(a)Manual, (b) Semi-automatic, (c) Automatic

Components of asphalt concrete Batch Plant are

1. Cold bins
2. Cold feed gate
3. Cold elevator
4. Dryer heater
5. Dust collector
6. Exhaust stack
7. Hot elevator
8. Screening unit
9. Hot bins
10. Weigh box
11. Mixing bowl or pug mill
12. Mineral filler storage

13. Hot bitumen storage 14. Bitumen weigh box

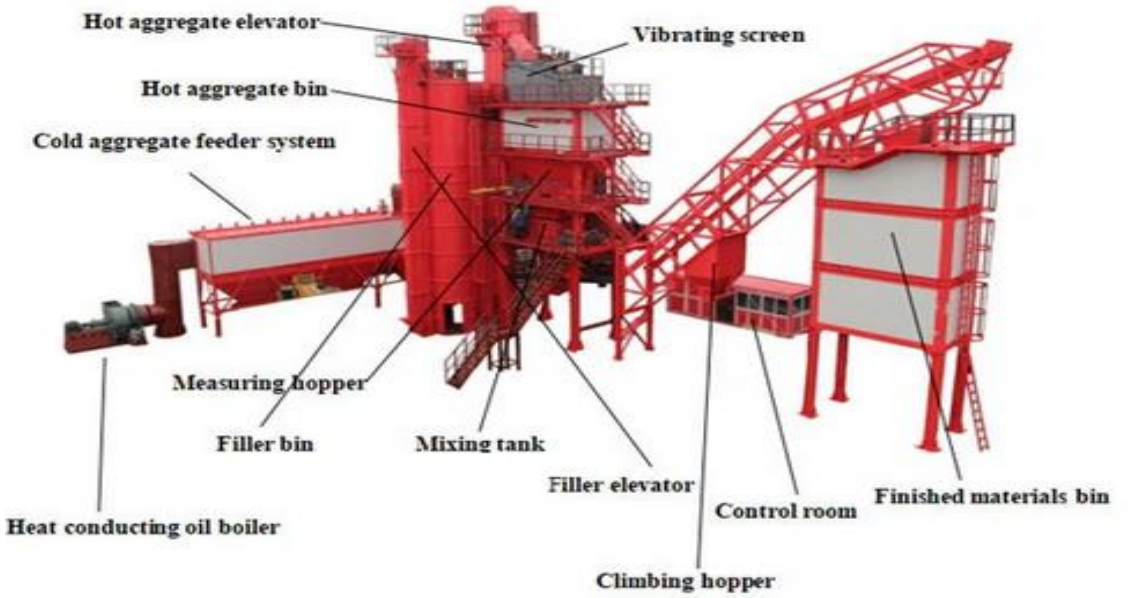

Figure 1-2 Components of an asphalt concrete Batch Plant

Aggregate is removed from storage, or stock piles, in controlled amounts and passed through a dryer where it is heated and dried. Basic requirements for batching plants are: Weigh Box or Hopper, Asphalt Cement Control, Mixer and Control of Mixing Time.

Cold feed (aggregate bin) gate: Cold aggregate feed is the first major component of the batch type asphalt concrete plant.

The cold feeder may be charged by one or a combination of the following methods:

- Open top bins with two, three, or four compartments, usually fed by a crane with a clamshell bucket or a front-end loader.
- Tunnel under stock piles separated by bulk heads. Materials are stock piled over the tunnel by belt conveyor, truck, crane, or front-end loader.
- Bunkers or large bins. These usually are fed by trucks, crane loads, or bottom-dump freight cars, which empty directly in to the bunkers.

Types of Feeders and Controls

Aggregate feeder units are located beneath the storage bins or stock piles, or in positions that assure a uniform flow of aggregate. Feeder units have controls that can be set to produce a uniform flow of aggregate to the cold elevator. Generally, belt and vibrator feeders are best for accurate metering of the fine aggregates. Course aggregate usually flow satisfactorily with any type of feeder.

Figure 1-3 Three-Bin Cold Feeder and Belt

Bins: Storage bins shall be divided into at least three compartments to provide separate storage of appropriate fractions of the aggregate. Provide each bin with overflow pipes, of such sizes and at such locations to prevent material from backing up into other compartments or bins. Provide each compartment with an individual outlet gate. The outlet gate shall not leak when closed. The gates shall cut off quickly and completely. The bins shall have means to sample the aggregates.

The Dryer: One of the basic units in any asphalt concrete plant is the dryer. It is a necessary part of the hot mix operation for it dries and heats aggregates coming from the cold feed supply, thus making them suitable for mixing with asphalt.

Drying is the most expensive operation in mix production. It is also the most frequently encounter red bottle neck in the plant operation. The best dryer is the one that meets a desired performance level at the lowest investment and operating cost. Most dryers are designed for average aggregate moisture content.

Temperature Indicating Device: An armored thermometer of adequate range shall be included in the bituminous feed line near the charging valve at the mixer unit.

Also, the plant shall be equipped with a dial-scale, mercury-actuated thermometer, or an electric pyrometer placed at the discharge chute of the drier to register automatically or show the temperature of the heated aggregate. The heat indicating device shall be accurate to the nearest 10 degrees F. Install the heat indicating device such that it will reflect a fluctuation of 10 degrees F on the aggregate temperature within one minute.

The Engineer may require replacement of thermometers by an acceptable temperature-recording apparatus for better regulation of the aggregate temperature at no cost to the State.

Aggregate temperatures measured by either a thermometer or at thermo couple attached to an indicating pyrometer. Pyrometers react much faster to changes in temperatures and are usually preferred.

An aggregate heat measuring device should be installed in the dryer discharge in full view of the burner operator.

Lime Dispersion

When lime is used in asphalt concrete, it must be mixed by pug mill or other approved Means to achieve a uniform lime coating on the aggregate prior to adding the asphalt Cement to the mixture. The method of introducing and mixing the lime and aggregate shall be subject to approval by the Engineer prior to beginning production.

The Dust Collector

The dust collector (Figure1-4) is generally operated adjacent to and in conjunction with the dryer, and is necessary for efficient plant operation. The collector eliminates or abates the dust nuisance that might result from exhaust air from the dryer. Modern dust-collection systems are highly efficient. Provisions are usually made in the dust collecting system to return the collected dust back to the hot aggregate a site merges from the dryer and picked up by the hot elevator.

A wet wash system may be added to the dust collecting system to reduce the amount offine dust being carried out the exhaust stack with the air. There are several types of wet systems, but they all usually consist of a short tower, with or without baffles. Exhaust from The Dust collector enters the tower at the bottom and passes upward through a series of water sprays that remove the dust. Use of a wet wash system usually will increase fan requirements by 10 to 15 percent because of the pressure loss in the tower.

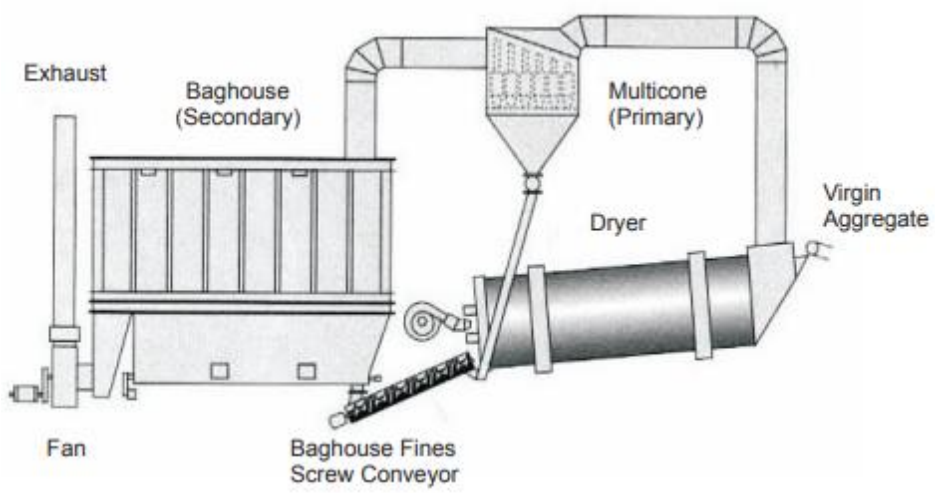

Figure 1-4 Dryer with Primary and Secondary Dust Collector

Screening Unit

Dried aggregates are generally transported from the dryer by a hot elevator and deposited onto a screening unit that is mounted over the plant bins. The function of hot screens is to accurately separate the aggregate into the specified sizes. (Figure 3-5). To properly perform this function, the effective screening area must be large enough to handle the maximum feed. Therefore, the capacity of the screens should be checked against the capacity of the dryer. The technician should observe the screens in operation to be sure they can handle the maximum feed.

Hot Bins

Hot bins are used to temporarily store heated and screened aggregate in the various size fractions required. Each bin should be large enough to prevent depletion of them material when the mixer is operating at full capacity. Each bin should have an over flow pipe to prevent aggregate from backing up in to the other bins.

Mineral Filler: Feed the filler, when used, to an accuracy of 10 percent of the required weight. Thoroughly dry the filler. Do not feed the filler through the drier system. Feed the filler material directly into the mixer as near the center as possible for batch type operation. Some asphalt concrete plants often have a separate feeding system for the addition of mineral filler to the mix.

Aggregate Weigh Hopper: Include a means for accurately weighing each size of aggregate in a weigh box or hopper suspended on scales and ample in size to hold a full batch without hand raking or running over. The gate shall close tightly so that no material shall leak into the mixer while weighing a batch.

Aggregates are released from the hot bins in to the weigh hopper, generally beginning with the largest size aggregate and progressing down to the finest size, with the mineral filler usually, if used, sandwiched between the larger aggregates.

Asphalt Bucket and Meter: Asphalt may be weighed in a special bucket, or it may be measured by a meter for each batch. When weighed in to a batch, asphalt is pumped in to a bucket of known weight and weighed on a scale. The volume of asphalt pumped between two-meter readings may be weighed as a means of calibrating the meter.

Truck and Plant Scales: The scale requirements shall apply only where proportioning by weight is used; Scales used in the weighing of materials paid for on a tonnage basis shall be approved and sealed in accordance with the requirements of the policies of the *approved agencies.*

Plant scales shall be accurate to 0.5 percent throughout the range to be weighed by the Contractor. The poises shall be locked in positions to prevent unauthorized change of position

Instead of plant and truck scales, an acceptable automatic printer system may be provided that prints the weights of the material delivered. Truck Scales weigh the bituminous mixture on acceptable

scales furnished by the Contractor or on public scales at no cost to the State. The Measurement Standards Division of the State Department of Agriculture or its authorized representatives shall inspect and seal such scales as often as the Engineer deems necessary.

Asphalt Storage

Asphalt storage at the plant should be equal to one day's output, and storage tanks should be calibrated so the amount of material remaining in the tank can be determined at any time. Heating may be done by the circulation of steam or hot oil through coils in the tank, or it may be done electrically.

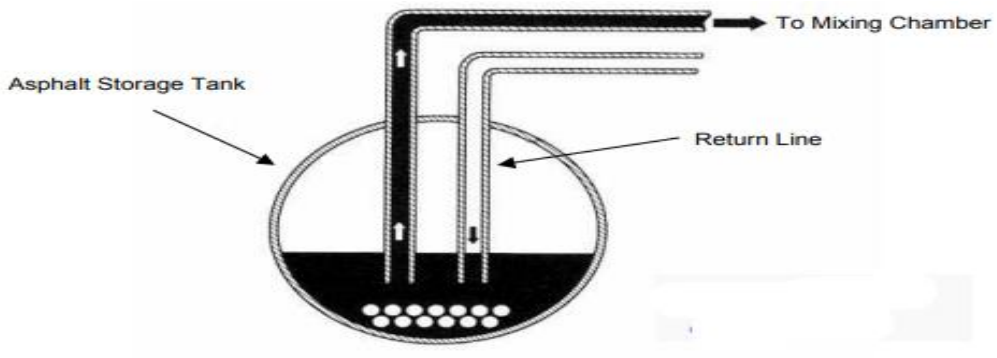

Figure 1-5 Asphalt return line

Pug mill

At win pug mill-type mixer is commonly used in all modern asphalt concrete plants. In a batch plant this unit is mounted directly be neath the weigh box and asphalt bucket, and high enough so that it may discharge the mixture into the truck or other hauling unit.

Mixing: Combine the dried aggregates in the mixer in the quantity of each fraction of aggregates required to meet the job-mix formula. Measure or gage and introduce the asphalt cement into the mixer in the quantity specified by the job-mix formula.

When aggregates are drawn from the hot bins as described earlier, some dry mixing takes place as the materials are deposited in the weigh hopper, as well as when deposited in the pug mill. The wet mixing time begins with the start of the flow of asphalt from the bucket or meter.

After introducing the required quantities of aggregate and asphalt cement into the mixer, mix the materials until a complete and uniform coating of the particles and a thorough distribution of the asphalt cement throughout the aggregate is secured. The professional/engineer will determine wet mixing time for each plant and for each type of aggregate used.

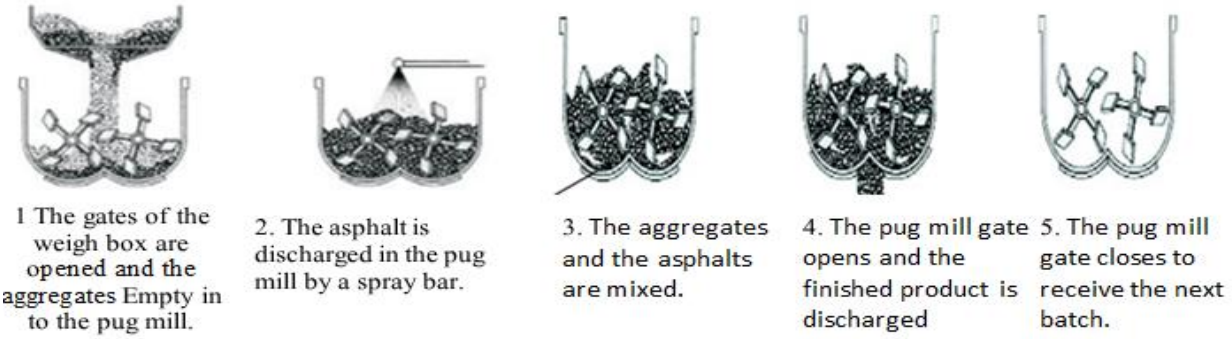

Figure 1-6 Steps in Typical Batch Plant Mixing Cycle.

Advantages of Batch Plant

- Modular design
- reasonable layout
- Quicker and more convenient disassembly-transportation-installation.
- The core components adopt internationally renowned brands, such as Siemens motors, EBICO burners, etc., which reduces the equipment failure rate and prolongs the service life of the equipment.
- Mass production and large output range can meet the needs of projects of different scales.
- It is equipped with a two-stage dust collector. The dust removal effect is good, and it is suitable for areas with higher environmental protection requirements.

1.3.2. General requirements for mixing plants

Mixing plants shall be capable of handling the proposed bituminous construction. Basic requirements for mixing plants are scale, equipment for preparation of asphalt cement, feeder for drier, drier, screen, bin, bituminous control unit, thermo metric, dust collector, safety requirements and mineral filler feed.

The asphalt plant is mainly composed of cold aggregate supply system, drum dryer, coal burner, coal feeder, dust collector, hot aggregate elevator, vibrating screen, filler supply system, weighing and mixing system, Pollution Control Unit , asphalt storage, bitumen supply system .

i) Drum Mix Plant

Drum mixing is a relatively simple process of producing a asphalt mixtures. The mixing drum looks like the familiar dryer. The difference is that the aggregate is not only dried and heated with in the drum, but also mixed with the asphalt cement

1.3.3. Requirements for Drier-Drum Mixing Plant

Drier-drum plants equipped with cold-feed control shall separate the virgin aggregate for Asphalt Concrete Mix No II into three or more sizes. Separate the virgin aggregate for asphalt concrete mix Nos. III, IV, V and VI into two or more sizes.

After separating the aggregates, store each size separately. Each of the storage, except storage for filler material, shall contribute a minimum of 10 percent to the total weight of the aggregate

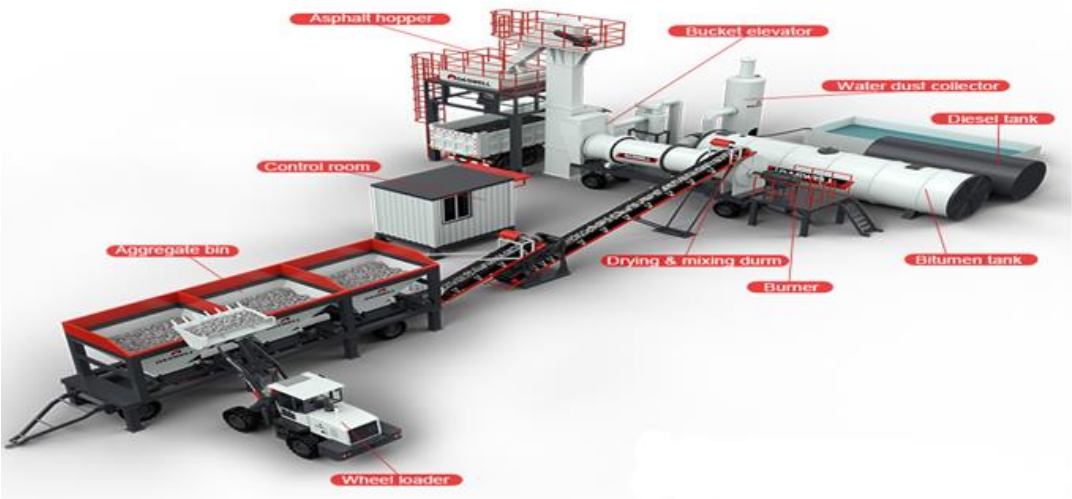

Figure 1-7 Component of Drum mix asphalt plant

Drier-Drum Mixing: Mix the aggregate, filler and asphalt binder in a drier-drum mixer. Mixing shall continue for a sufficient time and at a sufficiently high temperature that, at discharge from the mixer, the sizes of aggregates are uniformly distributed through the completed mixture and particles are thoroughly and uniformly coated with asphalt binder.

Discharge the drier-drum mixer into a storage silo or into a surge bin. Provide a means of diverting the flow of asphalt concrete away from the silo or surge bin, when starting and stopping the plant production, to prevent incompletely mixed portions of the mixture from entering the silo.

When using a surge bin:

- do not hold the mixture beyond one hour,
- do not segregate the mixture
- the mixture shall not be lumpy, and
- The mixture shall meet temperature and quality requirements of the contract.

The burner used for heating the aggregate in the drier-drum shall achieve complete combustion of the fuel.

Advantages of drum mix

- Compact structure and small footprint. It works well even in tight spaces.

- Easy to transport and transition. If necessary, it is equipped with a movable chassis and can be towed away directly by a trailer.
- Its internal structure of the drying drum is optimized, the heating speed is fast, and the stirring effect is good.
- The price is relatively cheap and the investment cost is low. It is cost-effective.
- The production process is simple and continuous production can be realized. The operation is simple and convenient.

Heating and mixing of the aggregates and asphalt cement is done in four phases.

Phase I -The aggregate has entered the drum mixer. In the early heating phase, surface and, free moisture begin to leave the aggregate as temperature rises..

Phase II-Most of the heaters occurs in phase II as aggregate temperatures reach approximately 170to180ºF (77to82ºC).The majority of the moisture is driven off in this phase and the rate of increase in mixing temperature levels off.

Phase III-As mix temperature reaches between 180 and 200°F(82and93°C) asphalt is introduced to the mix.

Phase IV - Most of the moisture has been removed. The aggregate has been coated, and mix temperatures will continue to rise until desired temperature is reached.

After the mix temperature has been achieved, the mix is discharged into a hot incline elevator that carries the mix to either a surge silo or storage tank (Figure 1-8), where it is held at a constant temperature until used.

Figure 1-8 Surge Silos or storage tank

1.3.4. Aggregate Moisture Determination for Drum Mix Operation

Moisture content of the aggregate must be determined because aggregate in a drum mix operation is weighed before dry. The moisture content of the aggregate should be determined and proper allowance made for the water content, prior to mixing. Perform moisture determination prior to start of mixing and thereafter as changes occur in the condition of the aggregate.

Moisture Determination of Aggregate: To establish the moisture content of aggregate being used, it is necessary to secure a representative sample of the aggregate.

The steps for this procedure are outlined as follows:

- Obtain **a representative sample** of the material from the production line (Conveyor belt)
- **Reduce the sample** to a size that can be handled by the weighing device by either a sample splitter or the quartering method.
- **Weight of aggregate** sample and record weight. (Wet weight).
- **Dry aggregate** sample thoroughly. The sample or samples are dried to constant weight on a hot plate or in an oven at a temperature of 230ºF (110ºC).
- Accurately **weigh the dried sample** and record weight (dry weight).In weighing and handling the sample, extreme **care** must be taken to avoid any loss of the material, as this will affect the accuracy of the results.
- **Determine Moisture Content.** The percent moisture is determined by the following formula:

$$\text{Moisture Content} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100$$

Example Wet Weight of Sample=1150g

Dry Weight of Sample=1080 g

$$\text{Moisture Content} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100$$

$$\text{Moisture Content} = \frac{1150 - 1080}{1080} \times 100 = 6.4\%$$

1.3.5. Mobile asphalt plant

The mobile asphalt mixing plant is named relative to the stationary asphalt plant. Because of its convenient movement and flexible transition, it has been welcomed by more and more customers in recent years. It is mainly suitable for projects with a short construction period and frequent transitions.

Its advantages

- The main components are equipped with trailers and chassis, which can realize quick relocation.
- Compared with the stationary asphalt plant, there is no need to lay the foundation in advance before installation, and it is more convenient to use.
- The core components are made of wear-resistant materials for longer service life.
- The main equipment is concentrated on the mobile frame, which occupies a small area and saves space.
- Adopt PLC control system, automatic control, and higher precision.

Difference between batch mix plant and drum mix plant

Different components: more components than the drum mix asphalt plant:
Different weighing systems: The weighing of the drum mix asphalt plant is relatively simple
Different mixing systems: The drying drum of the drum mix plant integrates the functions of drying, heating and mixing materials
Different dust removal systems: Batch mix asphalt plants equipped with two-stage dust removal but drum mix asphalt plant equipped with a first-stage dust removal.
Different quality of finished asphalt mixtures :the batch mix asphalt plant is better
Different capacities: The production range of the forced mix asphalt plant is 40t/h to 400t/h, while drum mix asphalt plant is 20t/h to 100t/h.
Different prices: The price of forced mixing asphalt plant is slightly higher than that of drum mix asphalt plant.

1.4. Shifting changeover details and Communication

1.4.1. Methods and Techniques of shifting changeover details

Shift changeover every reasonable effort shall be made by the employer to avoid scheduling the commencement of a shift within a given time of the completion of the employee's previous shift and to avoid excessive fluctuations in hours of work. Shift changeover the parties agree that there will be a shift changeover of a given fixed time at the end of the shift where it is deemed necessary. Outgoing operators will be required to give a full update to incoming operators during the given fixed time changeover to ensure a smooth handover. The shift changeover will be paid at overtime rates. Employees who cannot work the given fixed time changeover will need to discuss the individual

circumstance with their Process Owner. After discussion with their Process Owner any employee unable to comply with the requirement will not be compelled to work the fixed time changeover.
Employees are expected to ensure an effective handover between those employees finishing and employees commencing work, through the appropriate and efficient use of the employer's designated handover process. This shall be paid as overtime as provided for in this agreement.

Shifting changeover details includes:

- Right asphalt mixing plant?
- Determine the type of asphalt plant
- Consider the output of the asphalt plant
- Ensure the configuration of asphalt plant
- Consider the budget
- Consider whether the manufacturer is reliable
- Nature and scope of the work
- working conditions
- Achievement targets
- site lighting arrangements
- Defects on equipment
- hazards and potential hazards
- coordination requirements/issues

1.4.2. Information Communication

The more effectively you can communicate, the more successful you will be as a construction manager. A construction manager's whole job revolves around communicating: explaining the work that is to be done, discussing who is to do it, discussing performance expectations and actual performance, showing staff how something should be done, listening to people's opinions and ideas, and so on. Studies have shown that managers in general spend around 75 percent of their time communicating. Construction managers would be no different.
Communication is more than just telling someone something. It involves the transfer of information and understanding from one person to another. It is successful only when it is understood by the receiver in the way the sender intended.
Communication can take place in many ways. We can communicate symbolically through spoken or written words, drawings tone of voice and other forms of non-verbal communication and body

language. Most of our communications are through various combinations of these symbolic and non-verbal types. Even the clothing we wear sends messages to others.

1.5. Potential risks, hazards and environmental issues

1.5.1. Potential risks and hazards

Safety considerations are not always given the priority they merit during the manufacture and construction of HMA wearing courses. To provide good skid resistance properties based on pavement Design Manual Volume 1 (Chapter 8 Flexible Pavements - 2013 Bitumen-Bound Materials Ethiopian Roads Authority Page 8-9) during wet weather a wearing course must have a good surface texture to prevent aquaplaning at high speed. The coarse aggregate should also have good resistance to polishing to reduce the probability of slow speed skidding.

Assessment of risks and hazards include:

- Do not use asphalt concrete with hardened lumps in the mixture.
- Do not use the storage facilities that contained the material with the hardened lumps for further storage until the cause of the lumps is corrected.
- Abandoned equipment, adjoining pit walls
- Adverse weather conditions (electrical storms, floods, fires) , chemicals contaminants equipment, fences, holes, over-hanging rocks, pot holes, unsafe ground, unstable faces and vehicles.

Do not place the bituminous plant mix:

- on wet surfaces, as determined by the Engineer, or
- when the air temperature is below 50 degrees F. or
- When weather conditions prevent the proper handling or finishing of the bituminous mixtures.

1.5.2. Environmental Requirements

Environmental issues, the main consideration of asphalt mixing plant away from residential areas or densely populated areas, to avoid causing air and noise pollution

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

Environmental protection plan prior to commencing construction activities or delivery of materials to the site, the Contractor shall submit an Environmental Protection Plan for review and approval by the Contracting Officer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental, natural and cultural resources, and historic preservation issues which the Contractor must address during construction. Issues of concern shall be defined within the Environmental Protection Plan as outlined in this section. The Contractor shall address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but which the Contractor considers necessary, shall be identified and discussed after those items formally identified

In this section the Environmental Protection Plan shall be current and maintained onsite by the contractor. Environmental issues focused during construction and asphalt concrete production are:

- **Waste**: includes the collection, transport, treatment, and disposal of waste
- **Water quality**: include temperature, acidity (pH), dissolved solids (specific conductance), particulate matter (turbidity), dissolved oxygen, hardness and suspended sediment
- **Noise**: caused by machines, transport and propagation systems
- **Vibration** .Include movement of a tire on a gravel road
- **Dust** :emissions from the activities that generate airborne and fugitive dust and cause erosion
- Drainage ,Flora and fauna, Hazardous chemicals ,Recycling, Run-off, Spills

1.6. Application of computer systems and recording maintenance defects

1.6.1. Computer Systems and Equipment operation

Asphalt-concrete plants modernization to obtain polymer-bitumen binders in its own production using agitated mixers common in the chemical industry. Optimization problem is formulated for design and operating parameters of such equipment to provide required quality indicators for the resulting polymer-bitumen binders. Algorithmic and computer software assistance is developed to solve the set problem. The proposed technical solutions were tested when solving the modernization problems regarding the process diagram of the asphalt-concrete plant to release products on polymer-bitumen binder of its own production.

Application of computer systems and equipment operation used in asphalt paving operation .

The subject of this term was asphalt paving process utilizing machine and 20 tones capacity.

The overall process of asphalt paving operations;

- Hot mix batch plant cycle

- Tri-axle truck cycle
- Spreader cycle
- Roller cycle
- Crew cycle etc. because of the complexity of the overall construction process we chose to observe, reports on analyze and model the paving process on the base layers of the road.

1.6.2. Identify and Record Maintenance

Books, papers, maps, photographs, machine readable materials or other documentary materials. This definition applies to all departmental records including those created, received, and maintained by all contractors pursuant to their contracts. It is important to remember that depending on the content, e-mails are potential records and where applicable must be considered as such in accordance with recordings management program. Additional policy and guidance addressing e-mail records will be forthcoming in the record management manual and the record management hand books.

It is the responsibility of the contracting officer to identify which of the following categories of records will be include in the clauses contract owned record:

- Employment-related records except for this records described by the contract as being maintain in privacy act system of records.
- Confidential contractor financial information and correspondence between the contractor and other segments of contractor located away from the records management program.
- Accounts, records and inspection, are described as the property of the government.
- Legal records, including legal options, legislation files and documents covered by the client and work products privileges.

For disposition purpose, records are divided in to two types:

a. Permanent records are those records with special significance and enduring value.
b. Temporary records have limited and are retained only for a designate period of time prior to dispositions.

Self-check 1

Part I: True or False question

I. Instruction: Say true if the statement is correct and false if the statement is incorrect.

1. The asphalt material shall be delivered into the mixer in a thin, uniform sheet or multiple streams for the full width of the mixer
2. Increasing the dryer time will remove more moisture than increasing the heat.
3. During the drying operation, wet aggregate will reduce the dryer's capacity.
4. In the drum mix plant, moisture content of aggregate must be determined before drying

Part II: Matching

Instruction: Match Terms in column A with its meanings in column B.

	A	B
	1. The drier	A. Temporarily store heated and screened aggregate B. Mixture of aggregate binder and filler used for constructing and maintaining all kind of road parking area. C. Used to dries and heats aggregates coming from the cold feed supply D. Types of asphalt mixing plant E. Accurately separate the aggregate into the specified sizes
	2. Asphalt	
	3. Batch and drum	
	4. Screening	
	5. Hot bin	

Part III: Short Answer Questions

Instructions: Answer all the following questions accordingly.

1. What are some of the methods of controlling carry-over?
2. What is meant by proportioning of aggregates and asphalt?
3. What conditions will best insure a uniform flow of the proper aggregate sizes from the cold feed? 12. Why is proper cold feeding essential?
4. What problems arise from overheating?
5. What problems arise from under heating aggregate?

Operation sheet-1

Operation Title: Determining the Moisture content of Asphalt Concrete Mixtures

Purpose:

- To determine the moisture content of asphalt concrete mixtures

. **Required tools:**

- Pan
- oven
- Sample mixture
- Balance

Precautions:

- Calibrate the balance properly
- The sample quantity taken for the test should be ample so that for each pan, enough sample quantity mix is available for the test.

Procedures:

Step 1.Place mixture in pan.

Step 2.Weigh (both pan and mixture together) - Record the wet weight.

Step 3.Place in oven (set at compaction temperature) for approximately 30 minutes.

Step 4.Take sample from oven and weigh it - Record this weight.

Step 5.Place sample back in oven for approximately 15 minutes.

Step 6. Again, take sample from oven and weigh - Record this dry weight

(Repeat steps 5& 6 until the sample reaches a constant weight.)

Step 7.After a constant weight has been established, the percent of moisture is determined by the following formula:

$$\text{Moisture Content} = \frac{\text{Wet Weight - Dry Weight}}{\text{Dry Weight}} \times 100$$

NOTE: The moisture content of an asphalt mixture should not exceed 1percent.

Quality criteria: At the end of this operation, the tools and equipment clean and maintain.

LAP test

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I:

1. Apply site and equipment safety rules
2. Access tools and equipment appropriate to testing materials
3. Take appropriate samples material for a given task
4. Apply mathematical procedure/solution

Time allowed: 2 hours

Task 1: Determine Moisture content of Asphalt Concrete Mixtures

Unit Two: Allocate and log resources

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Hauling operation and allocate equipment's.
- Re-Allocate Construction Equipment
- Production requirements
- Personnel allocation for production
- record individual output

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Manage and monitor of Hauling operation
- Explain methods of allocate and re-allocate equipment's
- Determine Production requirements
- Identify Personnel allocation for production
- Show methods of recording individual output

2.1. Hauling operation and allocate equipment's.

2.1.1. Hauling equipment allocation

Hauling equipment machines used in construction to move and load materials. Logging equipment is any tools or machinery used in the asphalt production and transportation of logs. This could mean anything from the plant used to production asphalt concrete, the plant, and all the way to the trucks used to transport the logs before the asphalt have been felled.

Hauling: The activity of transporting goods by truck, Trucking, truck age. Shipping, transport, transportation -the commercial enterprise of moving goods and materials

A construction company or contractor can choose durable and reliable heavy equipment .There is many different types of logging equipment available in various construction sectors. These equipment types come from various construction sectors, including road building, demolition, building, forestry and more.

Various plants and equipment required for the asphalt concert productions includes:

- Milling Machines. Milling machines are used to remove the top layer of an existing pavement before a new asphalt layer is laid
- Dump Trucks: used to dump debris away from the construction site
- Mixer Truck: is a construction vehicle that combines cement, sand or gravel, and water homogenously to form concrete
- Sprayer: used to spray
- Mechanical mixer or improvised hand mixer
- Spreader –mechanical paver or finisher, grader, or manual method
- loader : move and load materials
- A compactor: designed to compress, reduce, and compact a variety of materials
- Excavator : used in digging or earth-moving operations
- Truck ; transportation of property or special purpose equipment
- Dump truck ; utilized at construction sites to transport construction materials to and from the site
- Rail vehicles and wagon: used for the transportation of cargo
- Roller: a compactor-type engineering vehicle used to compact soil, gravel, concrete, or asphalt in the construction of roads and foundations

Rollers shall be self-propelled and capable of reversing without backlash. Rollers shall be fitted with brushes or similar devices to enable the contact surface of each roll or tyre to be kept uniformly damp with a minimum amount of water and free from foreign material.

There are different types of mixer in use. Mechanical mixers include traveling plant or central plant and are employed depending up on job. Manual hand mixer is also used which is fixed vane type. Trucks hauling bituminous mixtures shall have tight, clean, smooth and metal beds that have been thinly coated with a minimum quantity of detergent, paraffin oil, or lime solution to prevent the mixture from adhering to the beds. The use of diesel or petroleum-based liquids, except for paraffin oil, to prevent the mixture from adhering to the beds is prohibited.

Each truck shall have a canvas cover to protect the mixture from the weather. Protect each load from the weather with the canvas extending over the top of the truck bed and securely fastened on all four sides of the truck bed.

Each truck shall raise their beds with tailgate closed before discharging to prevent segregation. Do not refuel equipment over newly paved surfaces. Refuel equipment over a catch pan or a surface that will prevent the fuel from coming in contact with the asphalt pavement. After the refueling operation is completed, remove the above devices until needed.

2.1.2. **Re-Allocate construction Equipment**

Good project management in construction must vigorously pursue the efficient utilization of labor, material and equipment. Improvement of labor productivity should be a major and continual concern of those who are responsible for cost control of constructed facilities. Thus material handling, which includes procurement, inventory, shop fabrication and field servicing, should allocate and require special attention for cost reduction. The use of new equipment and innovative methods has made possible wholesale changes in construction technologies in recent decades. Organizations which do not recognize the impact of various innovations and have not adapted to changing environments have justifiably been forced out of the mainstream of construction activities.

Construction steps:

Concrete asphalt primer should be substantially true to line and grade. It should have a dry or slightly damp, firm, and properly prepared surface before priming operations begin. Loose and foreign material should be removed.

The aggregate is first primed with a volatile mineral oil and then coated with bitumen. Mixing is carried out at about 90 – 100^{o}F and the volatile oil serves a dual purpose. In the first place it assists adhesion between the binder and stone.

Its fluxing action enables the mineral to be stored and laid cold, afterwards slowly evaporating from the finished surface; the aggregate used in this type of mixture consists largely of coarse aggregate sizes.

A British specification of 1927 was

- Asphaltic bitumen 5 – 6%
- Filler 3 – 5%
- Sand 10 – 12%
- Chippings (½ in – 3/8 in 77 – 82%

It was usually laid in two coats, totally 2in., or one coat 1 to 1½ in thickness;

The (dry) chippings were coated with kerosene, and to this was added dry, cold sand, filler, and the asphaltic bitumen at about 240 – 250^{0}F. The whole thoroughly mixed, and after cooling and stockpiling it could be laid cold after several days.

The essence of this type of surfacing is that the bitumen is cutback in situ, when brought in contact with the mineral aggregate which has previously been covered with the cutting liquid. After being raked in to a thin layer and rolled, the cutting liquid evaporates and the road is ready for traffic.

Another proprietary material that falls in to this category is ‘car pave’ w/c was introduced in 1925. It consists of 5 – 7% bitumen & 93 – 95% of a hard mineral aggregate, and was mixed hot but laid cold. The mineral aggregate was dried at about 100^{o}F and delivered to the mixer in two quantities. The first consisted of the coarse stone, from 1 ½ in to 1/8 or ¼, which was then mixed with a ‘liquefier’ which acted both as a wetting agent, a flux and a cutback, and then with a refinery bitumen; subsequently the finer aggregate was added , from 1/8 in. down wards and finally the filler.

The following are general steps/methods of construction for concrete asphalt

- **Preparation of existing layer**: The existing layer is prepared to the proper profile. Pot holes are patched and irregularities are made even. The surface is properly cleaned.
- **Tack coat or prime coat application**: The tack coat is applied of thin layer of bitumen binder on the existing layer either using the sprayer or a pouring can. The quantity of application is 4 to 7.5 kg per 10m2 for untreated layer.
- **Premix preparation**: The bitumen binder and aggregates as per recommended grading are separately heated to the specified temperatures and are then placed in the mixer chosen for the job. The mixing temperature for each grading and the bitumen binder is also specified based on

the laboratory results. The mixture is then carried to the site for its placement through a transporter or a wheel barrow.

- **Placement**: The bituminous paving mixture is then immediately placed on the desired location and is spread with rakes to a pre-determined thickness. The camber profile is checked with a template. It may be stated here that a compacting temperature also influences the strength characteristics of the resulting pavement structure. It is therefore require that the minimum time is spent between the placement of the mix and the rolling operations.
- **Rolling and finishing the paving mix**: The rolling is done with 8 to 10 tones tandem roller. The rolling is commenced from the edges of the pavement construction towards the center, and uniform overlapping is provided. The finished surface should not show separate lines of markings due to defectives or improper rolling. The roller wheels are kept damp, otherwise the paving mix may partly stick to the wheels and the finishing may not be good.
- **Application of seal coat**: In areas of low rain fall, a pre mixed sand seal coat is applied over the carpet. This layer is rolled by light tandem roller to give a smooth finished surface.
- **Opening to traffic**: The road may be opened to traffic 24 hours after providing the seal cot or surface dressing.

2.2. Personnel allocation for production

Productivity in construction is often broadly defined as output per labor hour or activities of personnel. Since labor constitutes a large part of the construction cost and the quantity of labor hours in performing a task in construction is more susceptible to the influence of management than are materials or capital, this productivity measure is often referred to as *labor productivity*. However, it is important to note that labor productivity is a measure of the overall effectiveness of an operating system in utilizing labor, equipment and capital to convert labor efforts into useful output, and is not a measure of the capabilities of labor alone

Monitoring of activities personnel include:

- **Contractors:** A person or company that signs a contract to supply materials or workers to perform a service or a job
- **Laborers:** entry-level position on road construction crews
- **Drillers** :Bore holes deep into the ground or others for different purposes
- **Drivers holders of appropriate tickets, licensed operators** :control the machines that drive
- **Maintenance staff/tradespersons** : an employee who has trade qualifications and has overall responsibility for maintenance at the place of employment and may be required to supervise other maintenance

- **Personnel authorized by site management** :supervision and management of all site-based staff employed
- **Service personnel**: provide an organization's services for customers.
- **Supervisors**: Check work is done correctly and according to the rules:
- **Surveyors:** Coordination activities may include:
- Communication with personnel
- Awareness of other support plant and equipment

2.3. Record individual output

Complete and accurate records of the amount and quality of the work performed are required. They document that work is performed in accordance with the plans and specifications and assure the Contractor receives proper payment for his work. Records also provide a means to maintain control of the work during construction and document the reasons for decisions and actions taken.

Project records must be sufficiently clear and complete to be understood by people unfamiliar with the details of the project and to sustain audit. Failure to keep such records is a failure to account properly for the expenditure of public funds. The importance of maintaining adequate and proper records cannot be overemphasized. Memory cannot replace valid permanent documents. Records of the amount and quality of work performed should include the "four W's" as follows:

WHAT: Identify the pay item involved (by both name and item number) and the quantity involved.

WHERE: List the project name and number as well as the specific location, such as project station and lane or offset.

WHEN: Note both the date and the time of day.

WHO: Sign the record. Initials are not acceptable unless your signature also appears in the record.

It is particularly important to have a record of any problems on the job (such as nonconforming work or changed conditions). This record should include any instructions given to the Contractor, or agreements made with him, to resolve the problem. Remember that the records have legal importance if there is a claim or other contract dispute.

Forms are available for nearly all materials tests and for inspectors' daily reports. Pay item books and diaries may be organized somewhat differently on every project. You should know what records you are to keep and in what form before you begin work on any project; ask your supervisor

A delivery docket record shall be generated showing:

(a) Empty and loaded mass of the vehicle date and time of loading;

(b) supplier and location of mixing plant;

(c) registration number of the vehicle;

(d) size and type of bitumen class of binder;

(e) Temperature of load at mixing plant.

Self-check 2

Part I: True or False question

I. Instruction: Say true if the statement is correct and false if the statement is incorrect.

1. Any tools or machinery used in the cutting and transportation of logs are logging equipment's
2. No need of aggregate primed with a volatile mineral oil and then coated with bitumen in concrete asphalt because it is coasty and tidies.
3. Car pave concert asphalt consists of 5 – 7% bitumen & 93 – 95% of a hard mineral aggregate, and was mixed **hot** but laid **cold**

Part II: Matching

Instruction: Match Terms in column A with its meanings in column B.

	A	B
	1. Milling Machines	A. Produce the smoothest finis B. Used to remove the top layer of an existing pavement before a new asphalt layer is laid C. Mechanical paver or finisher, grader, or manual method D. To break the liquid into droplets of effective size and distribute them uniformly over the surface or space to be protected E. Transporting from one location to another
	2. Trucker	
	3. Sprayer	
	4. Roller	
	5. mixer	
	6. spreader	

Part III: Short Answer Questions

Instructions: Answer all the following questions accordingly.

1. Define productivity in road construction?
2. Write all steps/methods of construction for concrete asphalt
3. Write all key elements in docket record?

Operation sheet-2

Operation Title: construction concrete asphalt

Purpose: To construct 2mX1m concrete asphalt

Required Material /tools

- Aggregate
- Aggregate spreader
- bitumen binder Sample mixture
- bitumen container
- Sprayer
- Burner

Precautions:

1. Apply site and equipment safety rules, Care from hot bitumen binder
2. Access tools and equipment appropriate to testing materials

Procedures:

Step 1. Preparation of existing layer:.

Step 2. Prime coat or Tack coat application:.

Step 3.Premix preparation:

Step 4.Placement:

Step 5. Rolling and finishing the paving mix:

Step 6 .Application of seal coat:

Step 7. Opening to traffic:

Quality criteria: At the end of this operation, the tools and equipment clean and maintain.

LAP Test

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I:

3. Apply site and equipment safety rules
4. Access tools and equipment appropriate to testing materials
5. Take appropriate samples material for a given task
6. Apply mathematical procedure/solution

Time allowed: 6 hours

Task 1: Construct Concrete Asphalt

Unit Three: Monitor and report plant/ machine activity

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Production requirement
- Aggregate and Sand Test
- Monitor supply of material to the cold bin
- Set proportion of material to batch requirements
- Store of mixed Material
- Test of mixed material

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Determining production requirements
- Testing aggregate and sand
- Monitoring supply of material to the cold bin
- Setting proportion of material to batch requirements
- Selecting Storing of mixed Material
- Testing of Mixed material

3.1. Production requirement

Provide and maintain a plant and all equipment necessary to produce and test asphalt. The main requirements for the production of asphalt and services are land, labor, physical capital, and human capital.

Production in construction is often broadly defined as output per labor hour. Since labor constitutes a large part of the construction cost and the quantity of labor hours in performing a task in construction is more susceptible to the influence of management than are materials or capital, this productivity measure is often referred to as labor productivity. However, it is important to note that labor productivity is a measure of the overall effectiveness of an operating system in utilizing labor, equipment and capital to convert labor efforts into useful output, and is not a measure of the capabilities of labor alone. For example, by investing in a piece of new equipment to perform certain tasks in construction, output may be increased for the same number of labor hours, thus resulting in higher labor productivity.

Construction output may be expressed in terms of functional units. Labor productivity is associated with units of product per labor hour, such as cubic yards of concrete placed per hour or miles of highway paved per hour. Labor productivity is identified with value of construction (in constant birr) per labor hour

Requirement step Process for Asphalt Pavement Installation and productions are:

- The plant shall produce a uniform mixture meeting the requirements of this Specification and the Nominated Mix within the tolerances specified.
- The bitumen storage tanks shall be capable of holding at least sufficient bitumen for one day's production. All tanks used for storage and preparation of bitumen shall be fitted with thermometers and circulating and heating equipment.
- Heating of bitumen shall be accomplished by steam coils, electricity or other means that will not allow any direct flame to come into contact with the heating tank. Tanks shall have a circulating system capable of providing continuous circulation of binder between the storage tanks and the mixer. Pipelines shall be insulated to prevent heat loss.
- The means for controlling the addition of bitumen shall at least have sufficient capacity to deliver bitumen in quantities not less than 10% of the mass of the combined aggregate.
- The bitumen shall be introduced into the mixer in such a way as to produce a uniform distribution.

- The binder feed unit shall be capable of supplying the specified amount of binder to the mix within ± 1% of the total binder either by weighting, metering, or volumetric measurement.
- Suitable means shall be provided either by steam or oil jacketing or by insulation, for maintaining the specified temperature of the binder in all pipe lines, meters, weigh buckets or spray bars and other containers.
- The binder feed unit shall be such that the heated binder is delivered in a thin, uniform sheet or in multiple streams the full width of the mixer except in the case of a mixer where the bituminous material is sprayed.
- An armoured thermometer with a range of 90ºC to 200ºC shall be fixed in the bituminous feed and near the discharge valve to the mixing device.
- When a bucket is used for weighing it shall have a capacity of not less than 15% of the rated capacity of the mixer. The bucket shall be steam-jacketed or equipped with electric heating units. Weighing equipment shall be accurate to ± 1 %.
- Screens shall be capable of screening hot aggregate into not less than four separate fractions (for batch and continuous plants).
- The plant shall include not less than four bins for the storage of the separate fractions of the hot aggregate (for batch and continuous plants).
- Each bin for the storage of the separate fractions of the hot aggregate shall be equipped with a mercury thermometer or electric pyrometer to register the temperature of the hot aggregate in the bin (for batch and continuous plants).
- Supply of asphalt from the bin for storage of hot asphalt shall not commence until the bin is filled to at least half capacity. If the level in the bin drops below this level once discharge has commenced, the bin shall be emptied before further asphalt is stored.
- Discharge from the plant shall be arranged so as to minimise segregation.
- The feeders on the cold storage bins for fine aggregates and added filler shall be equipped with warning devices to indicate any interruption to material flow.

. Factors Affecting Job-Site Productivity

Job-site productivity is influenced by many factors which can be characterized either as labor characteristics, project work conditions or as non-productive activities. The labor characteristics include:

- Age, skill and experience of workforce
- Leadership and motivation of workforce

The project work conditions include among other factors:

- Job size and complexity.
- Job site accessibility.
- Labor availability.
- Equipment utilization.
- Contractual agreements.
- Local climate.
- Local cultural characteristics, particularly in foreign operations.

The non-productive activities associated with a project may or may not be paid by the owner, but they nevertheless take up potential labor resources which can otherwise be directed to the project. The non-productive activities include among other factors:

- Indirect labor required to maintain the progress of the project
- Rework for correcting unsatisfactory work
- Temporary work stoppage due to inclement weather or material shortage
- Time off for union activities
- Absentee time, including late start and early quits
- Non-working holidays
- Strikes

Each category of factors affects the productive labor available to a project as well as the on-site labor efficiency

3.2. Aggregate and sand test

Constructing and maintaining pavements requires an abundant and dependable supply of quality aggregates. Aggregate comes from a wide range of materials, including quarried rock, sand, and gravel, and materials such as slag, reclaimed asphalt pavement, and recycled concrete aggregate. While all transportation agencies have specifications for aggregate quality, there is wide variation in what different agencies consider suitable aggregates for specific applications.

Therefore, before using for construction, it is necessary that they should be completely tested. Not only the aggregates should be strong and durable, but they should also have proper shape and size to make the element slab/pavement act monolithically. Hence, it is important to perform the tests on aggregates to ensure the quality of aggregates and check the properties of aggregate. The aggregates are tested to determine their properties like,

- Strength
- Toughness

- Hardness
- Shape
- Water Absorption etc.

The following are the different types of aggregate tests conducted to ascertain the suitability of aggregates**:**

- Crushing test on aggregates.
- Abrasion test on aggregates.
- Impact test on aggregates.
- Soundness test on aggregates.
- Shape test on aggregates.
- Specific gravity and water absorption test on aggregates.
- Bitumen adhesion test on aggregates

Aggregate test had seen in level II

3.3. Monitoring supply of material to the cold feed bin

Production starts with the cold feed bins. It is necessary to proportion the mixing drum. Total and proportional control with variable speed belt feeders permits adjustments of individual feeder output to desired proportions. (Figure 3-10) Thus total tonnage of aggregate going to the drum mixer can be increased or decreased by the speed of the feeder belts without changing the proportions.

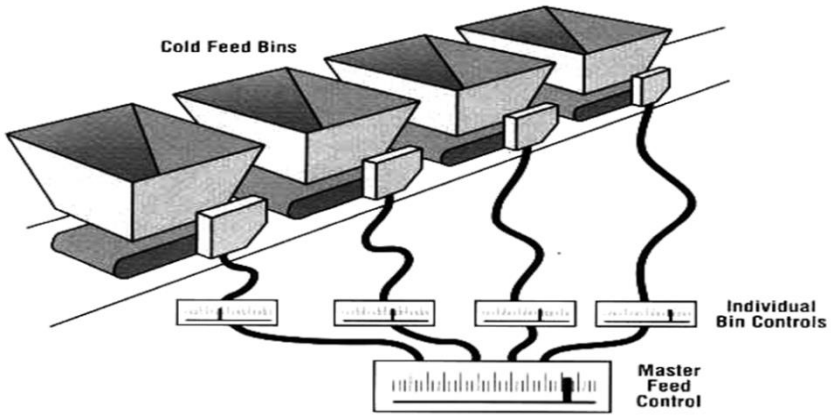

Figure 3-1 Cold Feed Control

3.4. Setting proportion of material Mix to batch requirements

3.4.1. Preparing the pre-mix

The process of mixing road metal with a binder of the road and then placing and consolidating the mixture on the road, is called pre-mixing.

From the point of view of both stability and economy the pre-mix method is superior to the grouting method. Pre-mixing permits of a denser mode of construction as graded aggregates are used which are well consolidated producing a compact surface, and at the same time uses much less binder and the danger of rutting or waving under traffic due to excess of binder is avoided.

i) Pre-mix method

In this group of methods the aggregate and the bituminous binder are mixed thoroughly before spreading and compacting. It is possible to coat each particle of aggregate with the binder still the quantity of binder used may be considerably lesser than penetration macadam type construction. In pre-mixed constructions, the quantity of bitumen used could be precisely controlled and they offer increased stability of the mix even with lower bitumen contents. Depending on the gradation of the aggregates chosen, premixed construction may be classified as open graded; semi dense and dense mixes. The common types of pre-mix bituminous construction are bituminous macadam, bituminous carpet, and bituminous concrete. Other type of bituminous pre-mixed construction includes sheet asphalt, and mastic asphalt.

ii) Bituminous macadam

Bituminous macadam(BM) or bituminous bound macadam is a pre mixed construction method of consisting of one or more courses of compacted crushed aggregates pre mixed with bituminous binder, laid immediately after mixing. The BM is laid in compacted thickness of 75mm or 50mm and three different gradations of aggregates have been suggested for each thickness to provide open graded and semi dense construction. The BM is essentially a base course or binder course and hence could be covered by a suitable surfacing course before exposing to traffic. BM base course is considered to be much superior to other types of base course materials such as WBM with respect to load dispersion characteristics and durability.

iii) Bituminous pre-mixed carpet

Pre-mixed carpet (PC) consists of coarse aggregates of 12.5mm and 10.0mm sizes; pre-mixed with bitumen or tar binder are compacted to a thickness of 20mm to serve as a surface course of the pavement. The PC consists of all aggregate passing 20mm and retained on 6.3mm sieve. When a

fairly well graded material as per specification is used for the construction of the bituminous carpet of thickness 20 to 25mm, the construction method is called semi dense carpet.

iv) Bituminous concrete or asphalt concrete.

Bituminous concrete or asphaltic concrete (AC) is a dense graded premixed bituminous mix which is well compacted to form a high quality pavement surface course. The AC consists of a carefully proportioned mixture of coarse aggregates, fine aggregates, mineral filler, bitumen and the mix is designed by an appropriate method such as Marshall Method to full fill the requirement of stability, density, flexibility, and voids. The thickness of bitumen concrete surface course layer usually ranges from 40 to 75mm.

v) Sheet asphalt

Sheet asphalt or rolled asphalt is a dense sand bitumen premix of compacted thickness 25mm, used as a wearing course. The sheet asphalt consists of well graded coarse to fine sand (without coarse aggregate) and a suitable penetration grade bitumen to form a dense and impervious layer. This is usually laid over cement concrete pavement to provide an excellent riding surface. The sheet asphalt also protects the joints in the cement concrete pavements and could cause a reduction in warping stresses due to a decrease in temperature variations between top to bottom of the concrete slab.

vi) Mastic asphalt

Mastic asphalt is a mixture of bitumen, fine aggregates and filler in suitable proportions which yields a void less and impermeable mass. Though the ingredients in mastic asphalt are similar to those in bituminous concrete, properties of mastic asphalts are quite different. The mastic asphalts when cooled results in a hard, stable and durable layer suitable to withstand heavy traffic. This material can also absorb vibrations and has a property so self-healing of cracks without bleeding. It is a suitable surfacing material for bridge deck slabs.

The filler, bitumen binder and aggregates are taken in suitable proportion and they are heated in sequence, and cooked at a temperature of 200oC to 223oC according to the binder grade, for over 5 hours in a special cooker. At a temperature of 200oC the mastic asphalt has such a consistency that it can flow.

vii) Mixing and heating of Material to the correct temperature

Based on temperature of the binder used, the most common type of asphalts are **Hot Mix** includes aggregate materials along with a binder that is heated at high temperatures (300+ degrees F) to remove moisture and reduce overall viscosity and **cold mix** (binder is not heated at all or lightly

heated but aggregate materials are not heated at all). Cut back and emulsion are used as binders in cold mix of construction. Hot Mix is a good all-around solution in warm conditions.

Generally, factors required for the design of concrete mix are

- Grade of Concrete
- Maximum Water – Cement Ratio
- Type of Cement
- Grading of combined Aggregate
- Maximum nominal size of the Aggregate
- Workability
- Durability
- Quality Control etc

3.4.2. Classification based on method of mixing

I. **Road mix method**- In this method of construction, materials are mixed at the road side with the help of improvised drum mixer or any other improvised method.

II. **Central plant mix method**. In this system, hot mix plant is situated centrally to the length of the road under construction. Heating of bitumen, heating of aggregate and filler, proportioning and mixing, all the processes are carried out in central hot mix plant at specified temperature. Prepared mix is directly discharged in to tipper trucks which immediately rush mix to the actual site of road construction, where they discharge the contents in the paver machine which intern spreads the mix uniformly over the prepared road surface to be treated.

3.4.3. Classification based on texture exhibited by compacted layers.

I. **Open graded**- They include surfaces exhibited by pre mix macadam and surface dressing without seal coat. They exhibit quite rough surface, after finishing.

II. .**Dense graded**- Well-proportioned or graded bitumen concrete pavements are termed as dense graded surface. Open graded pavements have lot of voids present in them and surface is very rough which require application of a seal coat to blind the top surface of the pavement and also to improve its riding qualities. Dense graded pavements have very little of voids (about 2%) and their surface is very smooth. dense graded pavements are, far superior to open graded pavements.

3.4.4. Preparing existing base course surface

Base course: - In road structure the base course is the layer immediately under the surface course (wearing course). Base course is subjected to several loading hence the material in the base course

must be of high load carrying quality, and the construction well done. The course is designated as 'sub-base'; the thickness of the sub base layers is controlled by the character of the under lying sub-grade over which it distributes the wheel loads delivered from above.

Priming: - Priming is the initial spraying of bituminous materials (bitumen) on to the following purpose:

1. Water proof the surface of base
2. To plug the capillary voids
3. to coat and bond loose particles
4. To harden the surface
5. To promote adhesion between the base and surface treatment.

Usually medium curing or slow curing cut backs of suitable grade or viscosity is chosen depending on the porosity of the surface to be treated. The bituminous primer is sprayed uniformly using a mechanical sprayer at a rate of 7.3 to 14.6kg per 10m2 area, depending on the porosity of the surface. The primed surface is allowed to cure for at least 24 hours, during which period no traffic allowed. Before the surface treatment, all of the asphalt prime volatiles must have evaporated.

3.4.5. Desirable requirements of bituminous mixes

A good bituminous paving mix should exhibit stability, durability, and workability and skid resistance properties, besides economy.

A. Stability: - It is the resistance of road pavement to deformation, from imposed vehicular loads. Unstable pavements exhibit rutting shoving and deformation under the tires of stationary vehicles. Stability is a function of friction and cohesion. Frictional resistance is dependent up on inter-particle friction and friction imported by bitumen. Cohesion is mainly dependent up on those factors which affect the viscosity of bitumen. Density and stability are interrelated properties. Density of compacted mixture is directly related to voids present in it. Strength property of the mix increases with decrease in void content. About 2 to 5% voids should be maintained in the compacted bituminous mix to allow for densification of pavement under traffic and expansion at high temperatures. If proper voids are not maintained bleeding and consequent skidding may result at higher temperature.

B**. Durability**: - It is the resistance against abrasion and weathering. Weathering property is dependent loss of volatiles and oxidation and causes hardening of the surface. Tensile strains are developed on the surface of bituminous pavement due to contact of tires of the plying vehicles.

C. Flexibility:-This property of the mix measures the capability of the surface in bending, without shearing or cracking.

D. Skid resistance: - This property of the bitumen mix is its capacity against skidding. It mainly depends up on the surface texture of the aggregate particle and bitumen content.

E. Workability: - It is a measure of ease with which a bituminous mix can be laid and compacted. This property is a function of the aggregate grading, shape of particles, texture of particles, types of bitumen used and bitumen content.

3.5. Storing of mixed material

The Contractor must implement procedures for storage and handling of binder that ensure prevention of segregation and contamination of the binder by flushing liquids or other materials.
Stored materials shall be separately stored under following classifications, with appropriate care necessary precautions to each Classification:

- Climatically Sensitive Materials
- Durable Materials
- Materials Vulnerable to Rough Handling
- Inflammable and/or Fire Sensitive Materials
- Hazardous Materials

At the asphalt manufacturing plant, polymer modified binder must be recirculate in delivery and/or storage tanks to a uniform consistency prior to use in the asphalt and the Contractor must clearly demonstrate adherence to the binder manufacturer's written recommendations in regard to storage times and storage temperatures.

Square or round silos designed for horizontal skip tracks for high installations or inclined skip tracks for low installations with or without load cells. It also is combined with an inclined skip track to horizontal skip. The silos are insulated / covered and are fitted with heated sector gates at the outlet and roller cover at the silo inlet. The round silos features 8 mm wear plates in the silo cone.

The silos are lined in a single or double row. The asphalt skip is operated as standard by a frequency regulated winch with integrated holding brake.

The asphalt skip on the horizontal track runs in X or X / Y direction with self-propelled frequency controlled transmission including brake and exact positioning system with feedback. The asphalt storage plant can be offered including full or partly covered skip track and silos.

Asphalt pavement resource distribution will be as follow:

Materials: aggregate, hot mix asphalt material.

Equipment: trucks, spreader, roller, batch plant or hot mix

Human resource: laborer, roller operator, paver operator, truck operator, Forman.

3.6. Testing of mixed material

Asphalt concrete paving mixtures should be evaluated for the following properties: stability, flow, air voids, stripping resistance, resilient modulus, compacted density, and unit weight.

Asphalt mix testing is critical for increasing the lifetime of a pavement. Weak asphalt mixtures can cause rutting and cracking, so to avoid premature pavement failure causing extensive damage and traffic safety issues, we must be able to adequately measure all the properties of the materials. This means that asphalt mix testing equipment must be able to perform quality control and quality assurance tests to determine which mixtures will succeed and which ones will fail.

In order to determine which mixtures will perform well, test conditions must accurately represent and simulate real road conditions – this is where performance testing comes into play.

There are three significant parameters that we believe are absolutely critical to measure:

- Stiffness
- Resistance to fatigue
- Rutting/permanent deformation

For density control of embankment, sub base, base course and H MA surfaces, a sufficient number of tests should be made to ensure that the specified results are being obtained. The frequency of testing will vary with the project, the placement operation and the material being used. For a job where compaction is relatively easy to obtain, the material is reasonably uniform and the compacting methods are consistent, a minimum number of tests are needed for acceptance. The minimum frequency of tests needed under these relatively ideal conditions follow. Most operations will require more tests for proper control.

Self-check 3

Part I: True or False question

I. Instruction: Say true if the statement is correct and false if the statement is incorrect.

1. Testing materials is an essential part of ensuring that works reach prescribed quality standards.
2. Strength property of the mix increases with increase in void content.
3. Construction output may be expressed in terms of functional units
4. Total tonnage of aggregate going to the drum mixer can be increased or decreased by the speed of the feeder belts without changing the proportions.

Part II: Matching

Instruction: Match Terms in column A with its meanings in column B.

	A	B
	1. Flexibility:-	F. The mix measures the capability of the surface in bending, without shearing or cracking
	2. Workability: -	G. The resistance of road pavement to deformation,
	3. Skid resistance	H. Measure of ease with which a bituminous mix can be laid and compacted
	4. Stability:	I. Capacity against skidding

Part III: Short Answer Questions

Instructions: Answer all the following questions accordingly.

1. Define pre-mixing
2. Factors Affecting Job-Site Productivity
3. Write characters of good bituminous paving mix
4. Write all different types of aggregate tests
5. Write basic properties determined in the aggregate test
6. The purpose of priming in the initial spraying of bituminous materials are

Unit Four: Monitor and report operational activities

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Report site operation and plant
- Location of equipment and material
- Report equipment usage and productivity
- Data for measuring operational outputs

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Introduce report site operation and plant
- Identify Location of equipment and material
- Identify Report equipment usage and productivity
- Explain data for measuring operational outputs

4.1. Report site operation and plant

Working of an asphalt batch plant will include heating and weighing of aggregates, heating and weighing of bitumen, weighing of filler material and in the end mixing aggregates, bitumen and filler material to produce hot mix asphalt

On the basis of an initial soil analysis and trial runs with the compaction equipment, the operators are instructed on how many passes they need to run the rollers and how much water should be applied to the soils.

Without this information, the operators may have problems determining when the job is done.

- Works should be verified before starting the next activity. Some activities require a form an inspection before the next can start. A good example is inspecting form works before allowing concrete to be poured. Equally, each layer in a road fill should be inspected before commencing works on the next layer.
- Proper supervision during the works provides essential work guidance and ensures that instructions are actually carried out as intended. For some important activities, it may be necessary to keep technical personnel present during the entire duration of the work activity.

After each work activity has been completed, quality controls are performed to check that the end product measure up to prescribed requirements. These tests are done using standardized procedures and testing equipment.

Operational details include:

- Plant operating capacity and target production rate. Process control testing frequencies for gradation, moisture, asphalt cement content, and compaction.
- Number and capacity of trucks, cycle time, and delivery rate.
- The manufacturer and model of the paver and pick-up machine to include information on grade followers, sensors, operating speed, and production rate of the pavers.
- . Number, type, weight, and operating speed of rollers, including replacement roller.
- Location and method of constructing longitudinal and transverse joints.
- Construction plan for paving intersections and driveways.

There are several components of operating an asphalt batch plant

- The first step is to use the cold aggregating bin to store and feed the aggregators in different components and sizes. There are also aggregate gates on individual bins that control the flow.
- There is a conveyor belt that transfers the materials into a drying drum. The drying drum comes with a heating unit that removes moisture, ensures the proper removal of oversized materials, and provides an optimal mixing temperature.

- Once the materials in the drying drum are heated, they are transferred to the tower. An elevator carries the materials to the top.
- The tower has three critical units: a vibrating screen, a hot bin, and a feeding bin. The vibrating screen separates and stores the materials in hot compartments for further processing. These materials in these hot compartments are weighed and then released in the mixing unit.
- In the mixing unit, the aggregates mix with bitumen and filler materials. After mixing the materials for a fixed time, the unit transfers the asphalt into batches in the waiting trucks.
- In many batch mix plants, there is also a control panel to help you monitor the machine.

4.2. Location of equipment and material

4.2.1. Location of equipment

Location of equipment defined as equipment location information to indicate **where** and **when** equipment is physically moved. All equipment used on work shall be of sufficient size and in such mechanical condition as to meet the requirements and to produce the work to the specified quality.
Usually a laborer is appointed for a distinct section of road close to his/ her home, typically 1 to 1.5 km in length. Labor provided with all the necessary hand tools to carry out all the routine maintenance activities as instructed by the commune authority.
Controlling the quality of works is a daily activity, which needs to be carried out during a work activity and again at the completion of works. When an activity is organized as task work, the quality is controlled at the end of the day before the task is accepted as complete. Usage of equipment needs to be carefully monitored to ensure that it is operated correctly and that its use actually achieves the set quality standards. In addition, the works are evaluated by carrying out a series of quality control tests.

4.2.2. Location of materials

According to ERA manual part-G (2013), the **haul distance** from the quarry/pit to the road site more than 10km, is not suitable due to high costs. The distance measured along the center line or most direct practical route between the center of the mass of excavation and the center of mass of the fill as finally placed. It is the distance material is moved. The economic haul or push distance for a bulldozer with a straight blade is from 17 to 90 meters depending on grade.

4.3. Report equipment usage and productivity

The equipment used shall include scarifying, mixing, dumping spreading, finishing, and compacting equipment, a self-powered bituminous material distributor, and equipment for heating bituminous material.

- The crushing and screening plant shall be capable of crushing and screening the aggregates, to be used for crushed rock or crushed boulder road base material.
- The pressure distributor shall be equipped with pneumatic tires and shall be so designed and operated as to distribute the asphalt material in a uniform spray without atomization, in the amount and between the limits of temperature specified. The distributor pump shall be motor-driven and shall be equipped with an accurate metering device registering litters per minute passing through the nozzles, which shall be so located as to be readable by the operator.
- A thermometer well shall be so placed in the distributor tank as not to be in contact with a heating tube. Suitable means for accurately indicating at all times the temperature of the asphalt material shall be provided.
- The distributor spray bar shall be adjustable, both for height and for the normal width of Application (3.5 meters) or less with a hand spray attachment. The distributor heating attachments shall be so equipped and operated that the asphalt material shall be circulated or agitated throughout the entire heating process.
- Rollers for compaction the surface shall be self-powered tandem or 3-wheel rollers weighting between 5 and 8 tones and having a minimum weight of thirty-six (36) kg/cm of rear wheel width, or a pneumatic tired roller with tire pressures in the range of 5-9 kg per square centimeter. Either traveling or stationary mixing plants or other equipment of proved performance may be used by the Contractor in lieu of the specified equipment if the Contractor complies with such requirements as the Engineer may consider necessary to insure results that shall be at least equal to results which would be obtained by use of the specified equipment.

The material shall be laid either by a self-propelled paving machine or by means of a grader. It shall be so designed and operated as to produce a mixture of laid material complying with the requirements of this Specification. The equipment used shall be of adequate rated capacity, in good working order.

Table 4-1 Effect of construction equipment and construction techniques on asphalt cement properties

Construction Related Factors Usual	Effect on Asphalt cement consistency	Mechanism
Drum Mixer Versus Batch Facility	Soften	Lower mixing temperatures are utilized in drum mixers. Possible unburned fuel contamination. Low oxygen environment.
Vibratory Roller Versus Pneumatic	Harden	Vibratory equipment may not seal surface and pavement is permeable to air and water thus more rapid hardening during service.
Bag House Versus Wet Washer System	Harden	Bag house fines are returned to mix which often changes the apparent viscosity of the asphalt.
Transport of Asphalt Cement in Contaminated Transport	Soften	Residual products in transport (often heavy fuel oil or cutback) soften asphalt cements
Mixing of Asphalt Cement in Storage	Soften	Blending of same grade asphalt cement from two crude sources may chemically interact to form an out of grade product; separation of asphalts may also occur.
Use of Anti strip Chemical in Asphalt Cement	Soften	Chemical interaction usually results in softening of this asphalt.
High Mixing Temperature	Harden	Higher mixing temperatures promote more rapid oxidation and volatilization of asphalt.
Hot Storage of HMA	Harden	Prolonged storage of hot mixes will promote oxidation and volatilization of asphalt unless the bin has a perfect sealing system or sealed with the injection of inert gas.

4.4. Data for measuring operational outputs

The asphalt concrete mixture shall be laid upon a surface approved in writing by the Engineer, spread and struck-off and compacted to the thickness specified in the drawings and specifications. Asphalt pavers shall be used to distribute the asphalt concrete mixture in lanes of such widths as to hold to a practical minimum the number of longitudinal joints required.

In road construction the location of natural materials has generally been regarded as specific task and incorporated into the costs for each project. In the case where there is a lack of reliable information and a degree of uncertainty regarding the location of acceptable materials, contractors usually quote a premium price. However if an accurate database of material resources was available it would greatly facilitate the planning and more accurate costing of construction projects. Materials appropriate to the road tasks could be more easily selected or shortfalls identified. Material costs could be better forecasted.

Measures of resource consumption are resource intensity and resource efficiency. The resource consumption rate of a production does not usually correspond with the primary resource availability, this is called resource curse.

Resource consumption measurement, analysis, and improvement in the context of sustainability in manufacturing reveal extensive resources and have become important in order to fulfill multiple requirements in ecological, economic and legislative activities. Resource consumption is a performance of the equipment and machinery involved within different processes

Self-check 4

Part I: True or False question

I. Instruction: Say true if the statement is correct and false if the statement is incorrect.

1. Works should be verified and planed before starting the next activity.
2. Technical personnel present during the entire duration of the work activity
3. Controlling the quality of works is a daily activity, which needs to be carried out during a work activity and again at the completion of works
4. Non-Chemical interaction usually results in softening of this asphalt.

II: choose the best answer

1. What is the importance of equipment and material location in construction works?
    A. To provide work guidance and ensure instructions are followed
    B. To determine the operational details of the equipment
    C. To prevent problems in determining when the job is done
    D. To check the location and method of constructing joints
2. What is the process of operating an asphalt batch plant?
    A. Monitoring the machine using the control panel
    B. Mixing aggregates, bitumen, and filler materials in the drying drum
    C. Transferring materials to the tower and weighing them in hot compartments
    D. All of the above
3. What is the role of proper supervision in ensuring instructions are carried out correctly?
    A. To prevent problems in determining when the job is done
    B. To provide work guidance and ensure instructions are followed
    C. To determine the operational details of the equipment
    D. To check the location and method of constructing joints
4. What are the components of an asphalt batch plant?
    A. Mixing aggregates, bitumen, and filler material
    B. Heating and weighing of aggregates, heating and weighing of bitumen, mixing aggregates
    C. Heating and weighing of aggregates, heating and weighing of bitumen, weighing of filler material
    D. Heating and weighing of aggregates, mixing aggregates, bitumen, and filler material

5. Where are joints constructed in asphalt paving?
    A. Drying drum with a heating unit
    B. Intersections and driveways
    C. Aggregate gates on individual bins
    D. Longitudinal and transverse joints
6. What is the role of quality controls in checking the end product of an asphalt batch plant?
    A. To determine the location of equipment and material
    B. To provide an optimal mixing temperature
    C. To ensure proper removal of oversized materials
    D. To check the end product of the plant
7. What is the location of equipment and material in construction works?
    A. In the tower with the vibrating screen
    B. In the drying drum with the heating unit
    C. On individual bins that control the flow
    D. Physically moved and close to the laborer's home
8. What are the operational details involved in asphalt batch plant production?
    A. Plant operating capacity and target production rate
    B. Number and capacity of trucks, cycle time, and delivery rate
    C. Manufacturer and model of the paver and pick-up machine
    D. Number, type, weight, and operating speed of rollers
9. Why is verification and inspection important before starting the next activity in construction works?
    A. To check the location and method of constructing joints
    B. To ensure the quality of the end product
    C. To prevent problems in determining when the job is done
    D. To determine the operational details of the equipment
10. What is the role of quality controls in an asphalt batch plant?
    A. To determine the type of rollers needed and the amount of bitumen to be applied
    B. To ensure the quality of the end product
    C. To determine the number of passes needed for the rollers and the amount of water to be applied
    D. To determine the temperature of the asphalt mix and the amount of filler material to be applied

11. What is the process of mixing aggregates, bitumen, and filler materials in an asphalt batch plant?
    A. Mixing aggregates, bitumen, and filler material
    B. Heating and weighing of aggregates, heating and weighing of bitumen, weighing of filler material
    C. Heating and weighing of aggregates, mixing aggregates, bitumen, and filler material
    D. Heating and weighing of aggregates, heating and weighing of bitumen, mixing aggregates
12. What is the purpose of soil analysis and trial runs in determining the operation of rollers and water application in an asphalt batch plant?
    A. To determine the number of passes needed for the rollers and the amount of water to be applied
    B. To determine the size of aggregates needed and the amount of bitumen to be applied
    C. To determine the type of rollers needed and the amount of bitumen to be applied
    D. To determine the temperature of the asphalt mix and the amount of filler material to be applied

Part II: Short Answer Questions

Instructions: Answer all the following questions accordingly.

1. Write down basic Operational details include in asphalt concrete production
2. Write all equipment used in asphalt concrete paves and their function
3. Write Transport of Asphalt Cement in Contaminated Transport Mechanism and Mixing of Asphalt Cement in Storage

Unit Five: Monitor movement of materials

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Log movement machinery and quantity of materials
- Monitor and reporting stock levels
- Monitor and reporting productivity rates.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Logging movement machinery and quantity of materials
- Monitoring and reporting stock levels
- Monitoring and reporting productivity rates.

5.1. Logging movement machinery and quantity of materials

Logging is the process of preparing, and moving materials to a location for transport. The asphalt shall be transported from the mixing plant to the spreader in trucks having tight, clean, smooth beds and sides which have been treated to prevent adhesion of the mixture to the truck bodies. All vehicles used for transporting hot asphalt shall be fitted with canvas (transport in excess of 10 km or cold. windy or rainy conditions prevailing) or other suitable approved covers (less than 10 km and moderate climatic conditions prevailing) to minimize temperature loss

Logging is the beginning of a supply chain that provides raw material for many products societies worldwide use for construction and user asphalt concrete production. Logging systems are also used to manage asphalt material, reduce the risk of environments and restore ecosystem functions.

In construction, hauling refers to primarily movement of excavated material or any other construction material. The equipment used for transportation of material is known as hauling equipment or simply haulers. Haulers may operate on the roadways or railways

It involves:

- transportation of building materials,
- carriage and disposal of excavated earth
- Haulage of heavy construction equipment.

Common movement machinery is trucks and loaders**.** Trucks are hauling equipment or units that provide relatively low hauling costs because of their high travel speeds and used for hauling asphalt mixtures. it should be clean, smooth and tight.it should contain thinly coated metal beds. Each truck shall have a watertight canvas cover of such size as to extend at least one foot (1') over the sides and end of the truck bed and be adequately secured to protect the Stone Mastic Asphalt Concrete mixture.

Because a log loader's ability to reach and lift is limited, match the size of the machine to your timber and landing arrangement. Machine size and the load's distance from the machine center will affect the lifting capacity of loaders.

Loaders on self-loading log trucks have both weight and distance limits. The larger the self-loader, the fewer payloads a truck can haul. Also, since self-loaders are mounted to trucks, and trucks must stay on smooth surfaces, self-loaders are constrained by being operable only from the road.

Loaders on forwarders are limited in lift capacity to what they originally loaded on the forwarder. Also, their reach is more limited than other loaders.

The unit cost of logging or road construction is essentially derived by dividing cost by production. In its simplest case, if you rented a tractor with operator for $60 per hour - including all fuel and other costs - and you excavated 100 cubic meters per hour, your unit cost for excavation would be $0.60 per cubic meter. The hourly cost of the tractor with operator is called the machine rate. In cases where the machine and the elements of production are not rented, a calculation of the owning and operating costs is necessary to derive the machine rate. The objective in developing a machine rate should be to arrive at a figure that, as nearly as possible, represents the cost of the work done under the operating conditions encountered and the accounting system in use. Most manufacturers of machinery supply data for the cost of owning and operating their equipment that will serve as the basis of machine rates. However, such data usually need modification to meet specific conditions of operation, and many owners of equipment will prefer to prepare their own rates.

5.2. Monitoring and reporting stock levels

Accurate records need to be kept on all materials supplied to the project and also where and when they are used. These records give details about date, movements (issued or received), quantity, origin and destination. Each entry is signed by the responsible supervisor or storekeeper. At the end of each month, it is common practice to count the contents in the stores and check the current holdings against the records of consumption.

On a regular basis, the project management reviews the contents and quantities of materials stored on site and assesses whether it is sufficient for the projected work activities. Before embarking on new activities, the staff in charge of procurement needs to stock up on necessary materials well in advance of the start of the work. Any items that are no longer in demand should be transferred to other sites or returned to the main store.

5.3. Monitoring and reporting productivity rates.

Equipment productivity generally refers to the time during which the machine is in operation performing productive work. The more efficiently the workers can complete their tasks, the higher the production level is.

Construction productivity is often measured as output per labor hour – how much work gets done in the time spent.

Output can be expressed in terms of physical quantities (e.g., square feet) or financial units (e.g., dollars). A good productivity percentage means that workers spend: 70–75% of their working hours working, and. 25–30% of their working hours on breaks.

$$\text{Productivity (growth) rates} = \left(\frac{\text{Current Productivity} - \text{Previous productivity})}{\text{previouse productive}}\right) * 100$$

If productivity increased from 80 to 84, then find the growth rate of productivity

$$\text{Productivity growth} = \frac{(\text{Current Productivity} - \text{Previous productivity})}{\text{Previous Productivity}} * 100.$$

$$\text{Productivity growth} = \frac{((84-80)}{80} * 100. = 5\%$$

An employee monitoring tool provides you with daily and weekly reports pinpointing total hours worked over a period along with hours spent on each task. Managers can then easily assess productivity rates at the individual, team, and firm levels to make informed decisions

Rates depend on market conditions, contractor requirements, and factors associated with each loading and hauling operation. They include:

- Haul distance, which translates into number of trips
- Loading time (loading efficiency and deck arrangement)
- Delays (from road conditions, scaling requirements, poor directions, etc.)
- Type of logs (species, diameters, and lengths—loads of small logs contain less volume than large logs, yet may be equivalent in weight and take more time to load)
- Type of truck (average volumes hauled are likely to be
  - 3,500–5,000 board feet for conventional trucks;
  - 2,500–4,000 board feet for self-loaders; and
  - 4,000–6,000 board feet for short loggers—truck and trailer loads) See Figure 5.1

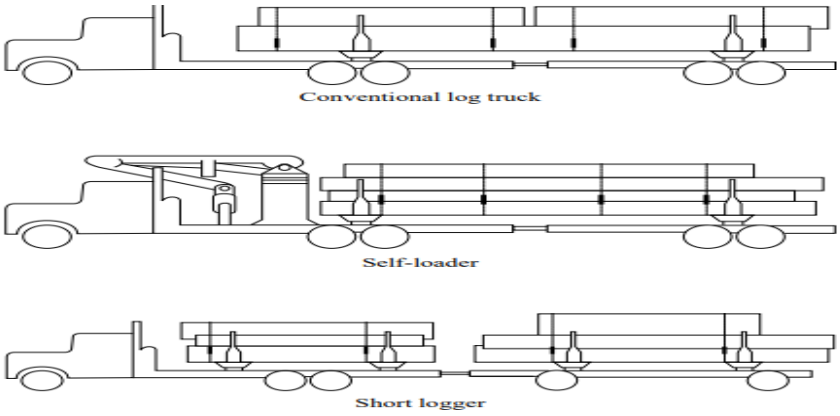

Figure 5-1 Type of log trucks

Volumes shown do not necessarily indicate truck capacity. Depending on many factors, load volumes will fluctuate. Specific information can be obtained from log haulers or neighbors who have had previous experience.

Self-check 5

Part I: True or False question

I. Instruction: Say true if the statement is correct and false if the statement is incorrect.

1. Define hauling equipment?
2. Why is productivity measurement important?
3. Write all factors that affect productivity rates**.**

II: Choose the best answer

1. What is the machine rate in logging or road construction?
   A. The cost of renting a tractor
   B. The unit cost for excavation
   C. The cost of owning and operating machinery
   D. The hourly cost of the tractor with operator
2. What affects the lifting capacity of loaders on self-loading log trucks?
   A. Weather conditions
   B. Weight and distance limits
   C. Age of the log loader
   D. Type of material being lifted
3. What information is recorded in accurate stock level records?
   A. Date, movements, quantity, origin, and destination
   B. Excavation rates, cubic meters per hour, and machine rates
   C. Transportation costs, fuel consumption, and labor hours
   D. Cost of renting equipment, machine rates, and production costs
4. What type of equipment provides relatively low hauling costs due to high travel speeds?
   A. Forwarders
   B. Excavators
   C. Trucks
   D. Loaders
5. What is the purpose of hauling equipment in construction?
   A. To restore ecosystem functions
   B. To excavate earth
   C. To manage asphalt material
   D. To transport building materials
6. What does the machine rate represent in logging or road construction?
   A. The unit cost for excavation
   B. The cost of owning and operating machinery
   C. The cost of the work done under operating conditions
   D. The cost of renting a tractor

7. Why is accurate record-keeping important in monitoring stock levels?
   A. To ensure compliance with environmental regulations
   B. To track the movement of hauling equipment
   C. To calculate the unit cost of logging or road construction
   D. To prevent theft or loss of materials
8. What are self-loaders constrained by in terms of operation?
   A. Weather conditions
   B. Smooth surfaces
   C. Rough terrains
   D. Weight limits
9. Who signs each entry in the stock level records?
   A. The construction workers
   B. The construction project manager
   C. The responsible supervisor or storekeeper
   D. The equipment manufacturer
10. How is the unit cost of logging or road construction computed?
   A. By calculating the total weight of materials transported
   B. By dividing the total cost by the quantity of materials transported
   C. By determining the distance traveled by hauling equipment
   D. By estimating the fuel consumption of hauling equipment
11. What is the process of logging in construction?
   A. Monitoring and reporting stock levels
   B. Counting the contents in the stores
   C. Excavating cubic meters per hour
   D. Transporting materials to the construction site
12. What is the purpose of counting the contents in the stores in construction?
   A. To excavate cubic meters per hour
   B. To track materials supplied and used
   C. To transport materials to the construction site
   D. To monitor and report stock levels
13. What factors affect the lifting capacity of log loaders?
   A. Age of the log loader
   B. Machine size and distance from the load
   C. Weather conditions
   D. Type of material being lifted

14. What does logging involve in construction?
    A. Transportation of building materials
    B. Management of asphalt material
    C. Excavation of earth
    D. Restoration of ecosystem functions
15. What is the equipment used for transportation of material called?
    A. Transportation equipment
    B. Hauling equipment
    C. Excavation equipment
    D. Loading equipment

Part II: Short Answer Questions

Instructions: Answer all the following questions accordingly.

1. Define logging
2. What is productivity of construction equipment?
3. How do you calculate equipment productivity?

LAP test

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I:

1. Write the formula
2. Apply mathematical procedure/solution

Time allowed: 30 minute

Tasks

1. Determine the productivity

   a. Four workers installed 720 square yards of carpeting in eight hours.

   b. A machine produced 70 pieces in two hours. However, two pieces were unusable.

2. A wrapping-paper company produced 2,000 rolls of paper one day. Labor cost was $160, material cost was $50, and overhead was $320. Determine the multifactor productivity

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