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Assessment of road pavement failure and Rehabilitation measurement along Dessie Kombolcha high way

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Abstract
Most of the roads constructed in Ethiopia fail prematurely before serving the design life due to various causes arising from many factors. One of these roads failed before reaching design life time is the Dessie Komblcha road.
Traffic system is most permanent problem of many countries but our country loses many life and money each day the main reason for this lose is pavement distress. Similarly our study areas have many damaged and distressed roads. Even if the government is under constitutional obligation to supply this basic social and economic service it's the most voice less problem of our country.
The main aim of the research will be assessment of pavement failure and rehabilitation measurements along Dessies Kombolcha high way measurement in Dessie town.
To make help full situation for this problem we will use the following methods the first method will be collecting information and data from the previous works and research. Then collecting samples from the study area analysis it on laboratory; it will have an interview with people some ideas making a help full job regarding with the asphalt distress.
In this paper the following results will be expected; those are factors of pavement failure; project will also provide additional inputs for construction advisers participate in the road maintenance.

Keywords: Roads constructed, Traffic system, road maintenance

1. Introduction
1.1 Back ground of the study area
Road is one of the engineering structure which connects country with country, city with cities, city with town, town to town, Kebele with Woreda, Kebele with Kebele. It is most essential component, without them it would be very difficult to move from one place to another in timesaving and smooth way. Therefore, proper design and maintenance could be carried out since roads built on weak sub-grade are no long durability results losses in both serviceability and economy. Pavement means that with which anything is paved; a floor or covering of solid material, laid so as to make a hard and convenient surface for travel; a paved road or sidewalk; a decorative interior floor of tiles colored bricks (Sharad, S., 2014) [17]. Pavement distresses are visible imperfections on pavement surface. They are symptoms of the deterioration of pavement structures. Distress evaluation, or condition survey, includes detailed identification of pavement distress type, severity, extent, and location. There are factors that affect rate of propagation. These factors may include pavement condition, traffic levels and distress severity. The distress density propagation on a new or recently overlaid pavement sections having excellent condition is expected to be slower than on pavement sections with poor condition (Abdullah, A.M., 2007) [1]. A distress is expected to behave differently on pavement sections subjected to different traffic levels. Also, the distress severity levels have an effect on behavior and propagation of distress density.
The Ethiopian Roads Authority has been working on developing the country's Road Network through expanding (opening of new routes), maintaining and managing the road network for the past 60 years. Most of the newly constructed roads failed before serving the design life time because of different reasons. Problems associated with design, workmanship and inter-pavement & surface water drainage are the main causes of these failures. The most common road distresses observed in many road failures are cracks, potholes, rutting, raveling, depressions, and damaged edges.

These distresses affect the safety and riding quality on the pavement as they may lead to premature failure and traffic hazards. Dessie to Kombolcha high way is one of the roads which failed before reaching design life time. This road is 30 km high way and very crucial for the country's transportation and tourism sector. One of these roads failed before reaching design life time is the dessiekomblcha road. Traffic system is most permanent problem of many country but our country loses many life and money each day the main reason for this lose is pavement distress. Similarly our study area have many damaged and distressed roads. Even if the government is under constitutional obligation to supply this basic social and economic service it's the most voice less problem of our country.

1.1.1 History of road construction and Rehabilitation in Ethiopia

A road construction work, just like any other social endeavor or undertaking, has vast and wonderful history of its own since it is evolved with the social development of mankind.

Movement on roads in ancient Ethiopia was done in trails and foot path. In addition to the traditional shoulder porter age, animals like mule, donkey and horses and camels were used as a means of transportation.

Historic chronicle of the 17th and 18th, centuries show that there were a number of small roads (trails and foot paths) in use in various small kingdoms of the country (ERA, 2001) [9].

Among those early Emperors that ought to be mentioned in line with those that played a significant role in this constructive field of endeavor in early Ethiopia, are Emperors such as Emperor Fasil, Rewords, Yohanes and Manilike.

If we look back to Ethiopian history and briefly try to visualize the genesis of road construction

Works, we note that some roads and bridges were constructed in early times. Emperors during their royal trips, used to exert efforts to make the roads suitable for their trips by having forests cleared and difficult terrains leveled. Some of the achievements that need to be quoted as an example are the bridge built on the Abay River during the times of Emperor Fasil in order to connect Gojjam with Gondar (Fakir Alebachew, 2005) [2].

During the reign emperor Rewords, planned road building efforts, although the technology was primitive, were also made. It was however limited in extent and conceived in strategic rather than economic terms (ERA, 2001) [9].

Emperor Yohanes IV, who succeeded Rewords, was also engaged in road construction. But due to the danger invasion by the Egyptians, debut and Turkish, the emperor was not able to achieve his desire.

Emperor Manila II was a successful road builder participating himself in the road construction. The first asphalt road appeared in 1903 in Addis Ababa. The Diredawa -Harare road was built as result of the agreement reached by the Emperor in 1894 GC in connection with rigging of railway line from Addis Ababa to Djibouti.

The Italians constructed many roads more than 6000 km, bridges all over the regions of Ethiopia using huge forced labor. However, their intention was to build roads and bridge to meet the requirements of political control rather than to promote the overall development of the country. Finally they abolished when the Ethiopians regained the power.

After 1991, Ethiopia embarked on a comprehensive economic reform program putting in place the condition for transition from command based economy to market oriented one.

ERA was reestablished with a view to provide strong administration under the leadership of the board. According to the proclamation in 1997, ERA is legally autonomous agency responsible for the management of the country's road. The primary function of ERA is to maintain the existing road network through the districts as its cooperative responsibility. The commitment of the government to improve the existing scenario of road infrastructure has been demonstrated by the fact that it has allocated substantial fund from its limited local budget. The government has prepared a ten year road sector development program (RSDP) that can be financed both by the government and the donor community (ERA, 2001) [9]. Accordingly, the RSDP investment allocation priorities have been base on the following;

Maintenance and rehabilitation works are given priority in order to preserve and improve the existing road networks so that existing assets are preserved and vehicle operating costs are reduced.

1.2 Statement of the problem

Major problem involving in Dessie to Kombolcha high way road is pavement losing functionality due to pavement distresses; land slide and weathering are the main problems. Before selection of maintenance option of the road pavement distress the identification of pavement distresses type and its possible causes is required. In addition information about Geology and Hydrogeology of the site is also required. Because it affects the engineering life of the road, pavement maintenance design, and the pavement failure maintenance cost. Pavement failure is highly determined by geology and drainage pattern since different geological materials (soils and rocks) affects engineering structure differently based on the water absorption nature of material (expansive soils are expanding during moisture and shrink during dry), and its resistance to weathering.

Drainage also affects the pavement strength in two ways those are moisture can enter the interface between the bitumen and aggregate and destroy the bond between it, and moisture can penetrate the bitumen itself and softening it and reducing its cohesive strength.

The landslide was activated during the construction of an asphalt road in 2009 and was formed on a moderate slope of 6.5° covered by alluvial sediments represented by silty clay (clayey silt) soils with an admixture of volcanic pebbles. So the land slide will be one if the major cause for the failure of dessie to kombolcha high way.

1.3 Objective

1.3.1 General Objective

The main objective of the research is to make general assessment of pavement failure and rehabilitation measurements along dessieskombolcha.

1.3.2 Specific objective

- To identify the caustic factors of pavement failure along dessi to kombolha high way.
- To understand processes and factor leading to pavement failure.

- To give information about the area for other interested researchers
- To identify types of distress present along Dessie to Kombolcha high way.
- To characterize the geology along the road.
- To review the ground water and surface water condition of the study area.
- To assess the possible maintenance options of pavement distresses of the study area.

1.4 Significance of the research

The maintenance of the pavement increases the serviceability of the road although good maintenance depends on identification of major causes of the distress. Therefore, assessment of distress, and identification of major causes is important for good maintenance of pavement distress. Assessment of the pavement distress, cause, and evaluation of possible rehabilitation measurement helps to identification of major factors of pavement distress, safe transport, and suggesting possible maintenance.

Upgrade the trunk and link roads to better standards so that the basis for modernization in terms of road infrastructure is acquired and expand the network through the construction of new regional and link roads.

2. Literature review

2.1 Introduction: Deterioration of highway pavement is a very serious problem that causes unnecessary delay in traffic flow, distorts pavement aesthetics, damages of vehicle and most significantly, causes road traffic accident that had resulted into loss of lives and properties,. Pavement surface deformation affects the safety and riding quality on the pavement as it may lead to premature failures.

During the present study a systematic and detailed literature review of the research problem has been carried out in order to establish a conceptual framework about pavement distress types, their associated causes and alternative maintenance and rehabilitation option.

Pavement distress varies depending on factors includes the type of construction material, the type of sub grade, drainage system, and climate and traffic levels. These problems range from very minor to very serious and to a complex one. Moreover, they can be localized or affect major part of pavement layers of the road. (Tarun, Z. 2013).

2.2 Performance and failure criterion of pavement distresses: Pavement performance evaluation is an important activity in the maintenance and rehabilitation works. It includes evaluation of existing distresses, road roughness, structural adequacy, traffic analysis, material testing and study of drainage condition. This section deals with types of bituminous surfaces, types and causes of distresses.

Generally, concepts of pavement performance include some consideration of structural performance, functional performance, and safety. The structural performance of a pavement relates to its physical condition, i.e. occurrence of cracking, faulting, raveling or other condition which would adversely affect the load carrying capacity of the pavement structures or would require maintenance. The functional performance of a pavement concerns how well the pavement serves the user (AASHTO, 1993) [5].

A typical flexible or bituminous pavement structure consists of the following pavement courses: sub- base, base, and bituminous wearing surface. The wearing surface is the uppermost layer of the pavement structure. In a flexible pavement, it is a mixture of bituminous binder material and aggregate. The binder may be sprayed on the surface followed by application of aggregate and referred to as a bituminous surface treatment. The binder and aggregate may be mixed in a central plant or mixed in place on the road and referred to as hot or cold mixes. The wearing surface may range in thickness from less than 2.5cm, as in the case of a surface treatment, to several centimeters of high-quality paving mixture such as hot-mix asphalt concrete. The wearing surface has four principal functions: to protect the base from abrasive effects of traffic, to distribute loads to the underlying layers of pavement structure, to prevent surface water from penetrating into the base and sub-grade, and to provide a smooth riding surface for traffic. (Alebachew, F., 2005) [2].

The base and sub-base are made using different materials designated the upper and lower base or sub- base. Where the soil is considered to be very weak, a capping layer may also be introduced between the sub-base and the soil foundation. This may be of an inferior type of sub-base material, or it may be the upper part of the soil improved by some form of stabilization (e.g. with lime or cement). The soil immediately below the sub base (or capping layer) is generally referred to as the sub grade and the surface of the sub grade is termed the formation level. The elements of a flexible pavement as defined above are shown in figure below. (Alebachew, F., 2005) [2].

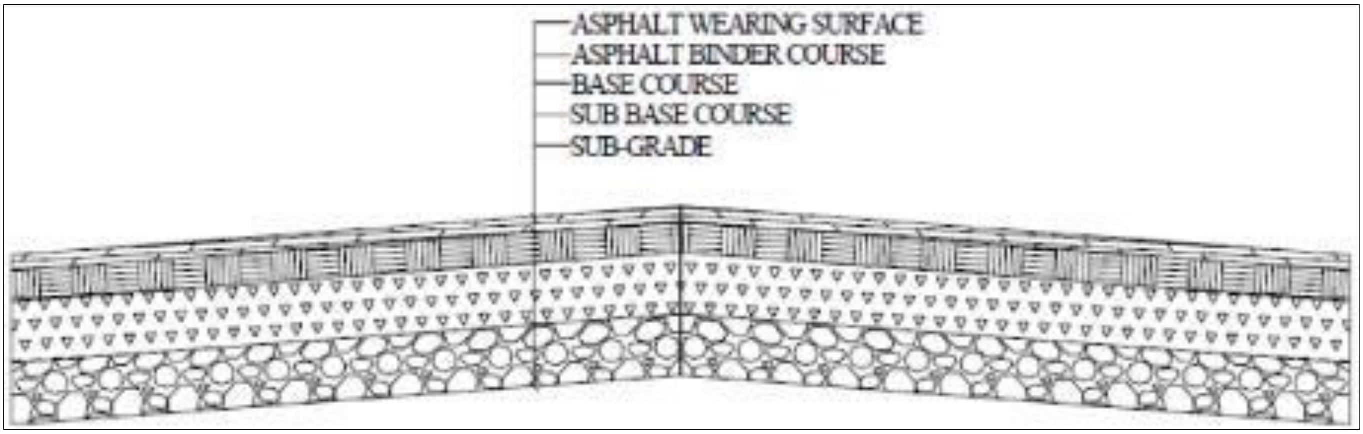

Fig 1: Elements of flexible pavement

Pavement deformation in the wheel path will start immediately following the passage of commercial vehicle over a flexible pavement. This permanent deformation in a well-designed pavement is fairly evenly distributed between the asphalted materials, the unbound base and sub-base, and the sub grade. In bituminous materials it may arise from additional compaction under traffic and from sideways displacement. (Girmay, T., 2016) [10].

2.3 Factors affecting pavement failures

A variety of factors contribute to pavement deterioration were investigated by many researchers "The Behavior. of Flexible Pavement on Expansive Soil", "Asphalt Pavement, a practical guide to design, production, and maintenance for Engineers and Architects", have revealed that pavement failure is attributed solely to poor design or method of construction. Lack of proper consideration of traffic loading, climate issues, materials quality and drainage issues are main causes of pavement failure due to poor design. On the Other hand lack of proper supervision of the construction, low quality construction materials, poor workmanship are the main causes of pavement failure attributed due to construction. Furthermore, he also suggested that poor highway facilities, no local standard of practice, poor laboratory and in-situ tests on soil and weak local professional bodies in highway design, construction and management will lead pavement failures.

Hence, proper pavement design shall have great contributions to

- Protect premature pavement failure,
- Limit the stresses induced to the subgrade by traffic to a safe level at which subgrade deformation is insignificant,
- Ensuring that the road pavement layers themselves do not deteriorate to any serious extent with in a specific period of time,
- Determining pavement thickness by evaluating sub-grade properties, subbase, base properties, and surfacing materials property, traffic loading and environmental factors.

2.4 Types of pavement distress

Pavement deterioration is the process by which distress (defects) develop in the pavement under the combined effects of traffic loading and environmental conditions. (Sharad. S.A, 2014,) [17] classifies pavement distresses in to four major categories. These are: Cracking, surface deformation, disintegration, and surface defects.

1. **Cracking:** This type includes fatigue cracking, longitudinal cracking, transverse cracking, block cracking, slippage cracking, reflective cracking, and edge cracking.
   a. **Fatigue cracking (Alligator cracking):** Fatigue cracking is commonly called alligator cracking. This is a series of interconnected cracks creating small, irregular shaped pieces of pavement. The lengths of the cracked pieces are usually less than 15 cm. The cracking pattern gives the appearance of alligator skin or chicken wire. (Girmay, T., 2016) [10].
   b. **Longitudinal cracking:** Longitudinal cracks are long cracks that run parallel to the center line of the roadway.
   c. **Transverse cracking:** Transverse cracks form at approximately right angles to the centerline of the roadway. They are regularly spaced and have some of the same causes as longitudinal cracks. Transverse cracks will initially be widely spaced (over 20 feet apart). They usually begin as hairline or very narrow cracks and widen with age. (Sharad. S.A, 2014) [17].
   d. **Block cracking:** Block cracking is an interconnected series of cracks that divides the pavement into irregular pieces. (Sharad. S.A, 2014) [17].
   e. **Slippage cracking:** Slippage cracks are half-moon shaped cracks with both ends pointed towards the oncoming vehicles. They are created by the horizontal forces from traffic. They are usually a result of poor bonding between the asphalt surface layer and the layer below. (Girmay, T., 2016, Sharad. S.A, 2014) [10, 17].
   f. **Reflective cracking:** Reflective cracking occurs when a pavement is overlaid with hot mix asphalt concrete and cracks reflect up through the new surface. It is called reflective cracking because it reflects the crack pattern of the pavement structure below. As expected from the name, reflective cracks are actually covered over cracks reappearing in the surface.
      They can be repaired in similar techniques to the other cracking noted above. Before placing any overlays or wearing courses, cracks should be properly repaired. (Alebachew, F., 2005) [2].
   g. **Edge cracking:** Edge cracks typically start as crescent shapes at the edge of the pavement. They will expand from the edge until they begin to resemble alligator cracking. This type of cracking results from lack of support of the shoulder due to weak material or excess moisture. They may occur in a curbed section when subsurface water causes a weakness in the pavement. (Alebachew, F., 2005, Girmay, T., 2016, and Sharad. S.A, 2014) [2, 10, 17].

2. **Surface deformations:** Pavement deformation is the result of weakness in one or more layers of the pavement that has experienced movement after construction. The deformation may be accompanied by cracking. Surface distortions can be a traffic hazard. The basic types of surface deformation are: rutting, corrugations, shoving, depressions, and swell.
   a. **Rutting:** Rutting is the displacement of pavement material that creates channels in the wheel path. Very severe rutting will actually hold water in the rut. Rutting is usually a failure in one or more layers in the pavement. The width of the rut is a sign of which layer has failed. A very narrow rut is usually a surface failure, while a wide one is indicative of a sub grade failure. Inadequate compaction can lead to rutting. (ORN 18, 1999).
   b. **Corrugation:** Corrugation is referred to as wash boarding, because the pavement surface has become distorted like a washboard. The instability of the asphalt concrete surface course may be caused by too much asphalt cement, too much fine aggregate, or rounded or smooth textured course aggregate. (Sharad S.A 2014) [17].

c. **Shoving:** Shoving is a form of plastic movement in the asphalt concrete surface layer that creates a localized bulging of the pavement. Locations and causes of shoving are similar to those for corrugations. (Girmay, T., 2016 and Sharad. S.A, 2014) [10, 17].

d. **Depressions:** Depressions are small, localized bowl-shaped areas that may include cracking. E) Swell: A swell is a localized upward bulge on the pavement surface. Swells are caused by an expansion of the supporting layers beneath the surface course or the subgrade. The expansion is Typically caused by frost heaving or by moisture. (Alebachew, F., 2005, Girmay, T., 2016, and Sharad. S.A, 2014) [2, 10, 17].

3. **Disintegration:** The progressive breaking up of the pavement into small, loose pieces is called disintegration. If the integration is not repaired in its early stages, complete reconstruction of the pavement may be needed. The two most common types of disintegration are: Potholes and patches

   a. **Pothole:** pothole is a bowl-shaped hole through one or more layers of the asphalt pavement structure, between about 6 inches and 3 feet in diameter (Alebachew, F., 2005, and Girmay, T., 2016) [2, 10]. Potholes begin to form when fragments of asphalt concrete are displaced by traffic wheels, e.g., in alligator-cracked areas.
   Potholes grow in size and depth as water accumulates in the hole and penetrates into the base and subgrade, weakening support in the vicinity of the pothole (Sharad. S.A, 2014) [17].

   b. **Patches:** A patch is defined as a portion of the pavement that has been removed and replaced. Patches are usually used to repair defects in a pavement or to cover a utility trench. Patch failure can lead to a more widespread failure of the surrounding pavement. The underlying cause is still under the pothole. Extensive potholes may lead to area repairs or reclamation. Reconstruction is only needed if base problems are the root source of the potholes. (Tarun, Z., 2013)

4. **Surface defects:** Surface defects are related to problems in the surface layer. The most common types of surface distress are: raveling, bleeding, polishing, and delamination

   a. **Raveling:** Raveling is the loss of material from the pavement surface. It is a result of insufficient bond between the asphalt cement and the aggregate. Initially, fine aggregate breaks loose and leave small, rough patches in the surface of the pavement. As the disintegration continues, larger aggregate breaks loose, leaving rougher surfaces. Raveling can be accelerated by traffic and freezing weather. Some raveling in chip seals is due to improper construction technique. This can also lead to bleeding. Repair the problem with a wearing course or an overlay. (Sharad. S.A, 2014) [17].

   b. **Bleeding:** Bleeding is a film of bituminous material on the pavement surface that creates a shiny, reflective surface. Bleeding is caused by excess asphalt cement in the mix and/or low air void content. During hot weather the asphalt fills the voids of the mix and then expands out onto the surface of the pavement. The process is not reversible during cold weather, thus asphalt binder will accumulate on the surface (NCDT, 2010)

   c. **Polishing:** Polishing is the wearing of aggregate on the pavement surface due to traffic. It can result in a dangerous low friction surface.

2.4.1 Environmental variation

Environment has great impact on material selection and thickness design of a pavement. The two critical areas of the environment that cause pavement failure are temperature and water/rainfall. Temperature affects the selection of which grade asphalt binder that would be used in the asphalt pavement. Asphalt pavements are susceptible to damage by water. Water increase moisture in the pavement and reduce bearing capacity, it saturates subgrade or base of an asphalt pavement and causes structural damage to pavement in climates that have extensive rainfall. The best prevention to structural damage due to provision of water is proper drainage. Inspection and cleaning of drainage system insures that they are working properly and will eliminate some of major causes of pavement failure.

Some of the most common modes of failure in the tropics are often different from those encountered in temperate region. It is further demonstrated that, climate also affects the nature of the soils and rocks encountered in the tropics soil forming processes are still active.

In accordance with the demonstration; in arid and semi-arid areas (in low rain fall areas in tropics), typically with rainfall of less than 500mm, and where evaporation is high, moisture conditions beneath a well-sealed surface are unlikely to raise above the optimum moisture content. In such conditions, high strengths (CBR>80%) are likely to develop even when natural gravel containing a substantial amount of plastic fines are used. In this situation some relaxation of PI and CBR can be made. Environmental conditions influence the performance of the entire pavement structure, including the subgrade.

Moisture affects the subgrade, sub base, or granular base, while temperature affects the asphalt mixture. For example; Materials of basic igneous rock origin are sometimes weathered and may release additional plastic fines during construction or in service. Problem is likely to worsen if water gains entry in to the pavement and this can lead to rapid and premature failure. The release of these minerals may lead to a consequential loss in the bearing capacity.

Climatic factors include rainfall and annual variations in temperature are an important consideration in pavement deterioration. Rainfall has a significant influence on the stability and strength of the pavement layers because it affects the moisture content of the subgrade soil. The effect of rain on road pavements can be destructive and detrimental as most pavements are designed based on a certain period of rainfall data.

In addition, rainfall is well established as a factor affecting the elevation of the water table, the intensity of erosion, and pumping and infiltration [S. Y. Wee, R. B. Chan. *et al*.]

Long periods of rainfall of low intensity can be more adverse than short periods of high intensity because the amount of moisture absorbed by the soil is greater under the former conditions. He further emphasized that water is the critical factor that cause road failures. Once water has entered a road pavement, the damage initially is caused by hydraulic pressure. Vehicles passing over the road pavement impart considerable sudden pressure on the water, this pressure forces the water further into the road fabric and breaks it up. This process can be very rapid once it begins. When vehicles pass over the weak spot, the pavement will start to crack and soon the crack generates several cracks. Water will then enter the surface voids, cracks and failure areas. This can weaken the structural capacity of the pavement causing existing cracks to widen. Eventually, the water will descend to the subgrade, weakening and hence lowering the CBR value of the subgrade on which the road pavement design was based upon.

(Wee *et al.*) reported that climatic changes in temperature and rainfall can interact together. Rainfall can alter moisture balances and influence pavement deterioration while the temperature changes can affect the aging of bitumen resulting in an increase in embrittlement of the bitumen which causes the surface to crack, with a consequent loss of waterproofing of the surface seal.

2.5 Poor Drainage

The highway drainage system includes the pavement and the water handling system which includes pavement surface, shoulders, drains and culverts.

These elements of the drainage system must be properly designed, built, and maintained. When a road fails, inadequate drainage often is a major factor. Poor design can direct water back onto the road or keep it from draining away. Too much water remaining on the surface combine with traffic action may cause potholes, cracks and pavement failure [Patil Abhijit *et al.*]. Inadequate drainage leads to major cause of pavement distress due to large amount of costly repairs or replacements long before reaching their design life. Drainage design for pavement is to keep the base, sub-base, subgrade, and other susceptible paving materials from becoming saturated or even being exposed to constant high moisture levels over time. Patil Abhijit *et al*. Investigated the effect of poor drainage on road pavement condition and found that the increase in moisture content decreases the strength of the pavement. Therefore, poor drainage causes the premature failure of the pavement. Little and Jones[D. N. Little, T. *et al.*]. Investigated moisture damage in asphalt pavements due to poor drainage. They found that the loss of strength and durability due to the effects of water is caused by loss of cohesion (strength) of the asphalt film, failure of the adhesion (bond) between the aggregate and asphalt, and degradation of the aggregate particles subjected to freezing. Moisture damage generally starts at the bottom of an asphalt layer or at the interface of two asphalt layers [N. P. Khosla, G.] Eventually, localized potholes are formed or the pavement ravels or ruts. Surface raveling or a loss of surface aggregate can also occur, especially with chip seals. [K. D. Stuart, 2001]

2.6 Expansive sub grade soil

Expansive soil as road sub grade is considered one of the most common causes of pavement distresses. Longitudinal cracking results from the volumetric change of the expansive subgrade, is one of the most common distresses form in low volume roads. This type of cracking is initiated from the drying highly plastic sub grade [A. Ahmed 2008] through the pavement structure during the summer [S. Sebesta *et al.*]. Other forms include fatigue (alligator) cracking, edge cracking, rutting in the wheel path, shoving, and pop outs. Problem of expansive soils results from a wide range of factors such as swelling and shrinkage of clay soils result from moisture change, type of clay minerals, drainage–rise of ground water or poor surface drainage and compression of the soil strata resulting from applied load. Expansive sub grades have an adverse effect on the performance of the pavement. When a new route is planned, the location of expansive soils must be known early in planning stage so that they can be avoided or treated if possible. If they cannot be avoided provision must be made for higher construction and maintenance costs which are inevitable [ERA 2002]. It is necessary to define the property of materials in the roadbed which undergo volumetric changes and thus affect the performance of the pavement further it is also necessary to determine the extent of the materials in the field and formulate the more effective and most economic construction or maintenance strategy to counteract these volumetric changes Hagos Gebretsadik (2006).

2.7 Maintenance and Rehabilitation Option

Pavements are costly not only to build but also to maintain. These costs are born by the owner funding the facility. Road users also cost a lot when operating their vehicles on deteriorated and poorly maintained roads. Hence, it is advisable to develop a definite action plan in order to keep asphalt road pavements in a continuous serviceable condition.

2.8 Maintenance Significances

Pavement maintenance is work performed from time to time to keep a pavement, under normal conditions of traffic and forces of nature, as nearly as possible in its as-constructed condition. It is also very important to allocate the limited resources available for the maintenance purposes in such a way that it satisfies objectives and maintenance polices of the roads authority.

The following basic approaches can be used to determine priorities for pavement maintenance: (Tarun, Z., 2013).

1. Urgent maintenance: Including emergency repairs to pavements that are cut, removal of debris and other foreign objects.
2. Routine drainage maintenance: Ditch cleaning and excavating, cleaning bridges, backfilling scoured areas, constructing check dams and etc.
3. Routine maintenance of pavement: Including patching, sealing and repairing of road furniture.
4. Periodic maintenance- it is resurfacing of local distresses. As indicated above the routine drainage maintenance should get more priority than the routine maintenance on pavements as repairing pavement surface defect caused by drainage problem is wastage of resource unless the drainage is first corrected (ORN 1, 1995, as cited in ERA, 2002)

2.9 Rehabilitation Concepts

Rehabilitation Work undertaken significantly extends the service life of an existing pavement. This may include overlays and pre overlay repairs, and may include complete removal and reconstruction of the existing pavement, or recycling of part of the existing materials. The primary function of the maintenance activity is to preserve the existing pavement so that it may achieve its applied loading, while rehabilitation is undertaken for significant increase in the functional life (Alebachew, F., 2005) [2].

A rehabilitation work comprises activities includes major resurfacing, restoration, rehabilitation and reconstruction of distressed pavement road. It can be considered as major maintenance operation that undertaken to considerably extend the service life of an existing pavement. Therefore, rehabilitation operations are different from routine or periodic maintenance in that the primary function of the latter activity is to preserve the existing pavement so that it may sustain the applied loading while rehabilitation is carried out to considerably prolong the functional life (Tarun, Z., 2013).

3. Research design and methods

3.1 General description of the study area

3.1.1 Location and accessibility: The Dessie basin (ca. 7 km long and 3 km wide; between 2,500 and 2,900 m a.s.l.) is one of the numerous "hanging" grabens located along the western Afar margin. The basin is bordered by two N-S trending steep slopes formed by the action of normal faults: the Tossa escarpment, up to 400 m high and up to 80 steep, to the west, and the AzwaGedel escarpment, lower (ca. 200 m) and more rectilinear, to the east. Both escarpments are topped by gently sloping surfaces, possibly corresponding to relicts of the ancient depositional top of the Trap volcanics before the opening of the Dessiegraben (Fubelli *et al*. 2008). SW-NE trending transfer faults border the basin both to the north and the south. Other faults, ranging in strike from NNW-SSE to NW-SE cross the area exerting a more or less direct control on the local topography. The northern sector of the basin is crossed by the Borkena River which flows eastward, to the Kombolcha basin (ca. 1,800 m a.s.l.), through a 60 m high waterfall and a 300 m deep narrow gorge locally named Doro Mezleya; its south-west sector is part of the Kelina River catchment.

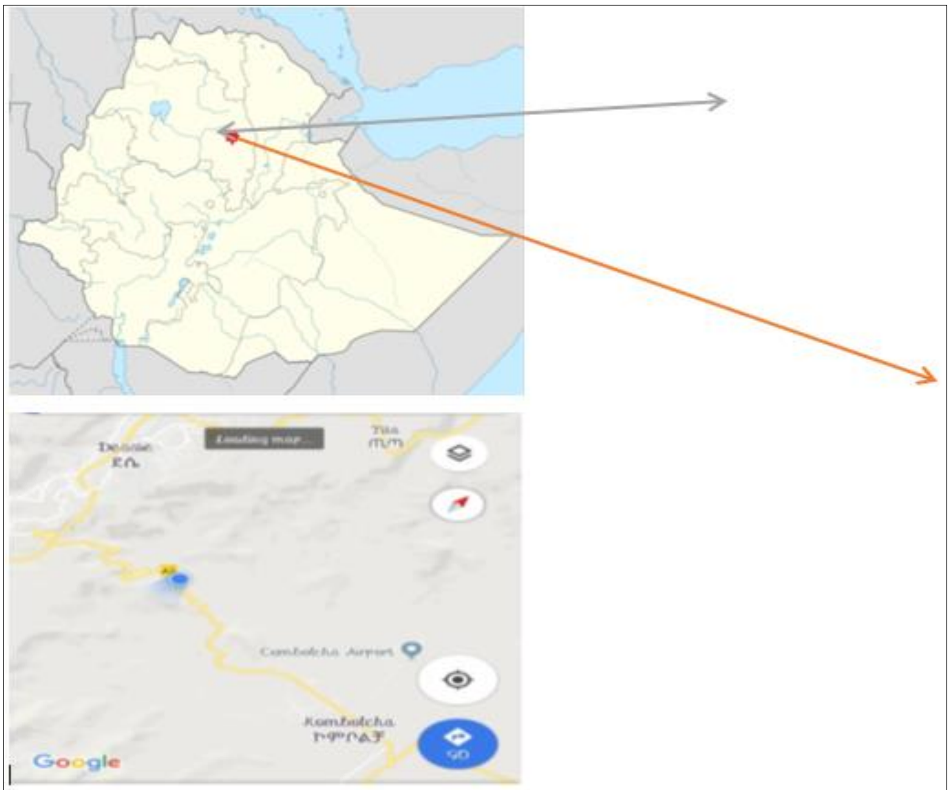

Fig 2: Location map of the study area

3.1.2 Climate

Dessie is located at an altitude of 2,470 meters (8,100 ft) above sea level in low- shrouded mountains and hills. Dessie has a subtropical highland climate. More to the east, there is a hot semi-arid climate.

Climate data of the study area

Table 1: Climate of the study area

Climate data for Dessie												
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average high °C (°F)	22.7 (72.9)	23.1 (73.6)	22.4 (72.3)	23.4 (74.1)	24.5 (76.1)	25.3 (77.5)	24.1 (75.4)	23.0 (73.4)	22.2 (72.0)	22.6 (72.7)	21.7 (71.1)	22.[illegible] (71.[illegible]
Average low °C (°F)	5.4 (41.7)	7.1 (44.8)	6.9 (44.4)	8.4 (47.1)	8.1 (46.6)	9 (48)	10.3 (50.5)	10 (50)	9.2 (48.6)	6.3 (43.3)	4.1 (39.4)	4.1 (39.[illegible]
Average precipitation mm (inches)	25 (1.0)	40 (1.6)	81 (3.2)	95 (3.7)	75 (3.0)	41 (1.6)	273 (10.7)	283 (11.1)	144 (5.7)	45 (1.8)	20 (0.8)	23 (0.9

***Source*:** Climate-data.org, altitude: 1,470m [8]

3.2 Methodology
In order to achieve the above mentioned objectives, the following methodology will be adopted;
- Literature review to acquire background information about general description of pavement
distress including distress type, cause, and possible maintenance.
- Field work
- Investigation of soils and rocks along the road alignment
- Collection of representative soils samples along the road alignment at kilometer interval and photographs at representative locations
- Record pavement distresses walking along the road alignment

The identified distress will be quantified and recorded using the following estimators
- Distress type - identify types of physical distress existing in the pavement.
- Distress severity - estimating the distress items in three damage levels i.e. low (L), medium (M) and high (H) severity.
- Distress extent - Denote relative area (percentage of the road section) affected by each combination of distress type and severity.

Pre-field work phase: to conduct this research the perquisite requirements was collected such as available materials to collect geological and engineering geological data and literature review. During the field work phase: In this phase the engineering geological and distress type of the asphalt was studied based on field description and in -situ tests.

3.3 Data Type
Both qualitative and quantitative data will be collected to counter balance the limitation of one by another. This data will be generate through personal interview and personal observation obtained from persons who related with our research topic and area.

3.4 Data Sources
All the necessary data required for the study will be obtained from the primary and secondary source; such as from government office annual and inventory reports, previous study and books. The primary data from collected house hold survey

3.5 Data collection techniques
Data that are collected for the study of evaluation on safe transporting system functioning Schemes were gathered through employing multiple methods including making field observation and reading different literatures related to the study.

3.6 Material used
The material used to conduct the research in field material includes (geological hammer, GPS,
Burton compass, camera, books and internet websites).

4. Conclusions and Recommendation
4.1 Conclusion
The present study was carried out on dessie to kombolcha high way. The total length of the road is 30 km. It was observed on high topography to low topography its elevation ranges from 2300 to 1500ft (dessie to komblcha) with decreasing temperature and also there are different pavement distresses are observed. Thus, keeping these facts in mind the present study area (from Arada to Komblcha) have different type of distresses. These distress types include alligator cracking, longitudinal cracking, edge cracking, rutting, swelling, bleeding, and Revalling. Those different types of pavement distresses are different types causes these includes sub-grade material, surface and sub-surface water, topography, temperature, and construction method. The study area is characterized as high amount and duration of rainfall, variable temperature (hot winter and dry summer), highly rugged, steep to cliff topography, and high traffic volume. The sum of those all factors causes pavement to be distressed. Load associated distress including Alligator cracking, Edge cracking, patching load cause distress, Potholes, and Rutting are dominant with in dessie city roads due to the high traffic volume in the dessie city.
The construction quality also affects pavement to be distressed in the study area because the cannel was not constructed on the both sides of road; this causes pavement to be distressed since the study area is gently to steeply sloped (most towards the road) due to this the rain water coming to the road and affects pavement in two ways, to erode the pavement surface and water percolated to the sub base through existing micro or mega sized fracture and results weakness of subgrade material. The possible maintenance options of that pavement distress are different based on the types of the distress and its causes. Maintenance of asphalt pavements consist of routine activities and periodic activities (Khaing, E. E., and Htwe, T. T., 2014, and Alebachew, F., 2005) [2] Routine activities include sanding, local l and poorly weldded soil. Sealing, crack sealing, filling depressions surface patching and base patching. Periodic activities include surface dressing, fog spray and slurry seal, asphalt overlays and pavement reconstruction.

4.2 Recommendations
The general recommendations based on the pavement distresses of the present study area;
- Acceptable method for determination of bearing capacity of expansive soil need to be further investigated
- Accurate traffic prediction models need to be devised throughout the country so that traffic forecasting errors would be minimized
- Relevant pavement structure need to be proposed for such heavy traffic important road section by thinking rigid pavement which have long standing resistance of heavy stresses.
- The area land slide problem should investigated more
- The local geology should study more
- The soil type and its factor on the high way should study
- Effect of level of ground water table on the expansive sub grade material needs to be further investigated
- In order to avoid the land slide risks and the burying the pavement with the sledded soil. so, the land slide recovery system must be done.
- When heavy traffic is expected materials like cinder which lacks plasticity and which does not stand lateral

pressures or susceptible to crushing under repeated load should be avoided.

- Funds required for proper and timely maintenance of roads should be provided to the organizations concerned.

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