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CAUSE AND EFFECTS OF UNPAVED ROAD DETERIORATION-A REVIEW

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ABSTRACT

The development and condition of the road environment are very essential for economic growth. Roads, in general, are classified in to paved and unpaved based upon the way of construction and surfacing material used. The larger percentage of Ethiopia road network is covered by unpaved roads. Any roads which are surfaced with gravel and earth are called unpaved roads. The most seen problems of unpaved road types are that these roads rapidly deteriorate and lost the surface material. This study was aimed to evaluate the surface material loss and deterioration for the unpaved road. Wide-Ranging literature about the factors of road deterioration was reviewed. The combined effects of excessive traffic loading, Poor material quality, poor drainage and road geometry ware taken as the main causes. The important maintenance activities which were necessary to keep a road and associated road structures in an acceptable condition for road users have been discussed.

1. INTRODUCTION

In developing country like Ethiopia Economic Growth highly depends up on agricultural sector. The road sector development among other basic rural infrastructure is very essential for economic growth. Hence agricultural products primarily located in rural areas and be transported to urban for income and business purposes. The mobility of people and goods is mainly depending up on transportation facility available. Road Transportation covers highest range in Ethiopia. Under the study of road transportation there are various influencing factors affecting the safety and comfort of users.

In Ethiopia, Roads are classified under two governmental administrative authorities who may control, execute, construct and manage every road asset. Such administrative bodies are Regional and Federal government Authorities. Roads are classified in to paved, unpaved and earth roads based up on the way of construction and surfacing material used. Paved roads are roads with Asphalt concrete and Portland cement concrete pavements. Unpaved roads are roads with surfacing material of gravel or other sub base materials and earth roads are roads with surfacing of locally available earth or soil type material. Unpaved roads deteriorate rapidly than a paved road because of it is susceptible to various factors as its construction cost is minimum. Therefore, unpaved roads should have given priority maintenance as its construction cost is minimum and maintenance cost is high.

The problem of Gravel surface is arising when there is surface materials loss and results in loss of profile and fail of slope and profile of gravel road segment from time to time. The finding and generalized conclusion of this study will significantly benefit the

road managing bodies by distinguishing the Loss of surface materials in unpaved roads specially in gravel access roads in order to account and allocate future maintenance budget requirement and the level of deterioration that affect traffic movement.This study mainly tried to investigate the following main areas

- The design consideration of unpaved roads
- The types and major factors that cause defects of unpaved roads?
- The maintenance and rehabilitation requirement of the un paved road
- Allocation of resources prior to maintenance and rehabilitation requirement by using condition forecasting, budget planning and inspection scheduling
- Practical engineering remedial measures the deterioration actions of unpaved roads

2. LOW VOLUME ROADS

According to design manual for low volume roads [1] Low volume roads in Ethiopia typically carry less than 300 vehicles per day and provide important linkages from homes, villages and farms to markets and benefit communities access to health, education and other services. These roads also provide important links between Kebele, Wereda and Zonal centres and the Federal road network. Demand for low volume road provision needs to be developed under a national policy driven by government and encouraged at the highest level. The cross-sectoral influence of low volume road provision and its role in deriving other sectoral development strategies and poverty reduction programs should be quantified.

According the definition of [2], low volume roads are roads with traffic volumes of no more than 400 vehicles per day, they have enormous impacts on economies, communication, and social interaction. Low-volume roads comprise, at one end of the spectrum, farm-to-market roads, roads in developing countries, northern roads, roads on aboriginal lands and parklands; and at the other end of the spectrum, heavy haul roads for mining, oil and gas, oil sands extraction, and forestry.

Although low volume roads carry few numbers of traffic, the largest percentage of transportation systems in developing countries were covered by low volume roads.Low volume roads can be sealed or unsealed. As stated by [3], Sealed Roads are all-weather dust-free surfaces. Sealing is done with a wide range of technologies from bitumen seal to thin (not load bearing) asphalt surfacing.

This study is intended to evaluate the deterioration of low traffic earth and gravel roads. Although there are many definitions of unsealed roads, gravel roads and earthen roads are the concerns of this study.

According to [1] the approach adopted for low volume road provision should complement national plans, policies and strategies and should complement to wider needs and demands, such as: The social and economic goals of poverty alleviation and development, Increasing rural accessibility, The use of new technology, promotion of the domestic construction industry and employment creation, Aware of Environmental protection and Minimize cost and improve efficiency.

Road Functional Classification						Geometric Standards	Level of Service	AADT
				TRUNK	HIGH VOLUME	DC8	A	>10,000
			LINK			DC7		3,000 - 10,000
						DC6	B	1,000 - 3,000
		MAIN ACCESS				DC5		300 - 1,000
	COLLECTOR				LOW VOLUME	DC4	C	150 – 300
FEEDER						DC3		75 – 150
						DC2		25 – 75
						DC1	D	<25
						Track		

Figure 1. Road classes in Ethiopia[1]

2.1 Design Parameters of Low Volume Roads

Climate, terrain, demographics and traffic are the principal factors affecting the design of low volume roads. Climate of the environment can play a significant role in determining the in-situ moisture content of the various pavement layers. The terrain of the location can be classified as flat, rolling, mountainous and escarpment. According to [1] flat terrain class has 0-10 five-metre contours per km. The natural ground slopes perpendicular to the ground contours are generally below 3%. Rolling terrain class has 11-25 five-metre contours per km. The natural ground slopes perpendicular to the ground contours are generally between 3 and 25%. mountainous terrain class has 26-50 five-metre contours per km. The natural ground slopes perpendicular to the ground contours are generally above 25% and escarpment terrain class Escarpments are geological features that require special geometric standards because of the engineering risks involved. Typical gradients are greater than those encountered in mountainous terrain.

To mitigate the effects of dust and improve the safety of road users and appropriate drainage systems, demographics of the location must be well known and Appropriate design approaches must be introduced in populous areas.

The number of vehicles passing a proposed road section needs to be taken account in design process. The number of vehicles passing a given section with in specific time interval is called traffic volume and is explained by AADT.

As defined by [1] the (Annual) Average Daily Traffic (AADT) is defined as the total annual traffic summed for both directions and divided by 365. It is usually obtained by recording actual traffic volumes over a much shorter period from which the AADT is then estimated. Where there is no existing road of any sort, the existing pedestrian traffic can be used to estimate the likely vehicular traffic after the road is constructed. Alternatively, traffic information might be available from an economic evaluation carried out to justify the road in the first place. In the unlikely event that there is no information available, the lowest class of engineered road (DC1) (see figure 1) should be provided.

The road pavement design and geometric design mainly based on traffic growth rates. The future traffic falls on the three categories.

- Normal traffic. Traffic which would pass along the existing road or track even if no new pavement were provided.
- Generated traffic. Additional traffic which occurs in response to the provision or improvement of the road.
- Diverted traffic. Traffic that changes from another route (or mode of transport) to the project road because of the improved pavement, but still travels between the same origin and destination.

According to explanatory notes of road (ERA), Geometric design is the process whereby the layout of the road through the terrain is designed to meet the needs of all the road users. The geometric standards are intended to meet two important objectives namely to provide minimum levels of safety and comfort for drivers by provision of adequate sight distances, coefficients of friction and road space for manoeuvres; and to minimise earthworks to reduce construction costs. The principal factors that affect the appropriate geometric design of a road are: cost and level of service, terrain, safety, pavement type, traffic volume and composition, roadside population (open country or populated areas), soil type, climate, construction technology; and administrative or functional classification

2.2 Low Volume Unpaved Roads

It was stated in [3] that, unsealed roads are the roads that have no permanent surface proofing of water. There are three classes of unsealed roads.

1. Unengineered Roads or Earth Roads: are the roads which have no drainage, cross fall, added granular material or other features that would ensure all-weather access.
2. Engineered Roads: are the roads which have a reasonably well-defined cross section, including drainage. They usually consist of locally available earth material with no added surfacing material.
3. Gravel Roads: are the roads which are built and designed to certain engineering principles, including the supply, where warranted, of gravel wearing surface. Construction of these roads also involves a defined cross section, drainage and structures (bridges, culverts).

The major technical challenges for unpaved roads are to provide surfacing with materials that provide the desired and necessary level of service and to provide effective maintenance management. Vehicle operating costs are high on unpaved gravel roads with high roughness and restricted access. Vehicle operating costs include vehicle repairs, maintenance, fuel consumption, tire replacement and others. The consequence is that transport operators tend to avoid roads with high roughness and other defects

forcing people to walk long distances to reach. The dust is often a main problem on unpaved roads. It is caused by the action of traffic and wind [1].

An economic evaluation of various maintenance strategies or the management of unpaved roads is dependent on a reliable determination of level and type of deterioration and the value of maintenance operations. The rate at which maintenance and gravel resurfacing should be applied are dependent on the economic variation between the costs of the maintenance and the benefits to be gained from increasing level of service. Empirical prediction deterioration models therefore, need to determine the effective rates of deterioration as a function of traffic, road geometry, material properties, climate and the surfacing maintenance type used [4].

a. Gravel Road

Gravel road is defined as a road surfaced with processed, generally crushed and screened, imported granular aggregate. Gravel roads are generally unpaved roads that may give service to the traveling public and are usually have given lowest attention than to paved roads.

Gravel for road works is a non-renewable natural resource. It is used on unpaved roads as a sacrificial layer and must be periodically replaced. Gravel roads require a continuous cycle of reshaping and regravelling to maintain the required running surface and the desired level of service. The nature of the climate and the terrain presents significant challenges to achieving this type of maintenance. Screening and blending techniques are available to improve the properties

Gravel is a mix of stone, sand and fine-sized particles used as sub-base, base or surfacing on a road. Gravel surfaced roads are virtually always referred to as unpaved roads. Gravel roads are generally unpaved roads that may give service to the traveling public and are usually have given lowest attention than to paved roads.

As stated in [5] there is about 82.4% of gravel road in Ethiopia and the remaining 17.6% road is paved. Gravel roads in general give access for community. Moving from place to place for social, political and economic experience and market exchange should improve the development of the whole country.

According to [6], gravel roads are often considered to provide lower quality service than paved road surfaces. Yet, in many rural regions, the volume of traffic is so low that paving and maintaining a paved road is not economically feasible. Budget constraints are causing some agencies to revert failing paved surfaces to gravel surfaces. Consequently, understanding gravel road design, construction, and maintenance is very important.

As stated in guide lines for the design of gravel roads[7] the major component of road networks in developing countries are unpaved roads, and it is impossible to decrease the overall percentage of unpaved roads in developing countries in the near future, and thus methods for improving the design and maintenance of unpaved road networks is of critical importance. Most of the time unpaved roads are presently designed with little input resources and constructed from the nearest available materials and resources. There for minimal attention is often given towards providing adequate formation, effective drainage or selecting suitable construction materials. In addition, minimal maintenance is carried out in many developing areas. Gravel Roads have a specified layer of imported material which is usually constructed to a specified standard and width and is intended to provide an all-weather surface. The geometric alignment is also compliment to appropriate national or international standards. Gravel roads generally should have given degree of maintenance by a recognized road authority and a higher level of service is provided. Gravel road may not be appropriate where the quality of surface material is poor, rainfall intensity is very high and traffic volume is high, longitudinal gradient is greater than 6% and adequate maintenance may not be provided. Gravel roads have low construction cost but have high maintenance cost. The approach for major gravel road is as follows:

- The sub-grade should be prepared well before wearing course hauling should be started and most of the time it is known as roadbed preparation.
- It is assumed that the surface wearing course material dumping should be applied at intervals related to the expected annual gravel loss.
- The geometry and road cross sectional elements are upgraded to acceptable minimum levels during construction.

Major gravel roads are likely to generate high maintenance costs in some circumstances;

- When the quality of the surface material is poor.
- Where no sources of gravel are available within a reasonable haul distance it means off-set distance of quarry site from the road is very large.
- Gradients of the road greater than about 6%.

- In areas of high and intense rainfall.

b. Earth Roads

As stated by [8], earth Roads is road with a usage of up to 50 vehicles per day. Drainage, road planning, the actual construction, and subsequent maintenance operations are all dealt with.

Earth Road is One or two compacted layers of ordinary soil or stabilized soil of the foundation and wearing surface. earth roads can be Ordinary Earth Road. Or Stabilized Earth Road. When the compacted layers are constructed from a natural soil available along alignment of the road is used for the foundation and wearing surface then such type of road is called as are the ordinary Earth Road. And when it is from stabilized soil then it is called as stabilized Earth Road. Stabilizing action of earth road may not be economical but it depends on the difficulty condition of existing soil and traffic load.

According to the notes of [9], earth roads are very important as the construction of earth road is a fast process, Proper selection of the gradient give balanced earthwork, In future if other type of road is going to be constructed on the existing earth road, it gives good foundation and The overall process is relatively cheaper than other road types. But the disadvantages of this roads indicate that these roads are only useful for light traffic. It cannot sustain the lifespan of the road if it is allowed for heavy traffic. This type of road wears quickly and the maintenance is little bit costlier and This type of road cannot be constructed or it will be worthless in the areas where monsoon is on peak or areas that have maximum rainfall, as constant and excess rainfall lashes out these kinds of roads.

2.3 Defects on Unpaved Roads

The nature of surface and strength of the underlying soil is critical in determining the performance of low volume roads, particularly in periods of wet weather.

As [3] stated, road Failures can be classified as structural and surface defects. the failure of the sub-grade or pavement layers results Structural defects. Material used, depth of pavement, road geometry and/or poor drainage are the major causes for structural defects. Patches on surface, larger depressions or loss of pavement are symptoms if Structural defects. Surface defects such as: roughness, corrugations, potholes, rutting, scouring/erosion, raveling, loss of surface material, dustiness, stoniness and slippery surface mainly affect ride quality.

According [10] Typical defects which may affect unpaved roads are dustiness, potholes, stoniness, corrugations, ruts, cracks, ravelling, erosion, slipperiness, impassability and loss of surfacing or wearing course. Most of these have a direct effect on the road roughness and safety.

Figure 2 cracks on gravel road**Figure 3** Ravelling on gravel road

According to the study of [11], Typical road surface distress which affect Gravel Loss are dust, ravelling, erosion. As the definition of the study, Dust is the release of silt sized particles (5 – 75 µm) of fine material from the road surface. Ravelling is surface defects mainly caused by a deficiency of fine material, and hence cohesion, a poor particle size distribution and inadequate compaction. And Erosion is the loss of materials caused by the flow of water.


Figure 4 Dust in gravel road**Figure 5.**Stoniness in gravel road

As stated by [12] for the limited volume of traffic, paving and maintaining a road is not economically feasible. Economic constraints for gravel roads are the only option that can be provided. Three major factors identified as affecting gravel road surface deterioration were climatic, traffic and the influence of blading. Material properties and road geometry and road cross section influence the gravel loss generated by each of these factors.

The causes of deterioration combined with the extent of the failures must be considered together when selecting the most appropriate method of maintenance or rehabilitation. Therefore, the cause and extent of gravel road should be primarily identified and to be recommended for remedial measures.

2.4 Main Causes of Defects

When gravel surface deteriorates, change in gravel surface thickness over a period of time. This will result in surface roughness, a lot of undulation and rutting. Three are a lot of factors which affects the surface condition of gravel roads. The major influences were weathering specially rainfall, traffic characteristics, Alignment, gradient, surface cross-fall, road width, material quality, compaction and frequency of maintenance in the form of blading, can be expected to all significantly influence rates of material loss. Surface material loss is specific to the material used and the location.

Gravel roads passing through populated areas in particular require materials that do not generate excessive dust in dry weather. Places with steep gradients in particular demands on gravel wearing course materials, which must not become slippery in wet weather or erode easily. Consideration should therefore be given to the type of gravel wearing course material to be used in particular locations such as towns or steep grade sections.

The major technical challenges for unpaved roads also as stated by [1] are to provide durable and functional water crossings, surfacing with materials that provide the desired and necessary level of service and to provide effective maintenance management.

As stated by [13], the types of deterioration and the number of condition classes vary between different countries. On the basis of this study that a combination of traffic-dependent, geometric and physical factors govern deterioration, which in turn may lead to inadequate drainage capacity, potholes, rutting, corrugations, dust, loose gravel and frost damage.

According to [14], the amount of dust that a gravel road produces varies greatly depending primarily on the type of surfacing material, traffic volume and type of vehicles whether heavy or light and annual precipitation in the location. The quality and type of gravel has a great effect on the amount of dust generated. When the fines are lost from a gravel surface, the stone and sand sized particles remaining will tend to become loose on the surface, leading to some distresses like wash boarding and reduced skid resistance.

According to the study of [15], loss of surface material is particularly vital for gravel roads, where the loss or replacement of lost surface material that shall costs.

Selecting road projects with different deterioration reasons [16] investigated field survey and laboratory testing on those projects to examine the existing pavement conditions. The results revealed the investigated roads experienced severe failures in the forms of cracks, potholes and rutting in the wheel path. According to the study, the causes of those failures were found mainly linked to poor drainage, traffic overloading, expansive subgrade soils and the use of low-quality materials in construction.

Rates of gravel surface defects are influenced by various factors depending on road geometry, material quality, traffic numbers and type, climatic conditions, construction standards and maintenance practices. The traffic volume and rainfall, combined with lack of strength and cohesion in pavement materials, leads to a loss of pavement materials. Surface material is lost by the actions of scouring, 'kick off', dust, attrition, stones breaking down through the passage of heavy vehicles and on weak subgrades traffic ingress pavement materials into the subgrade. According to Several recent studies [17, 18, 10, 19, 20, 11, 15], gravel loss mainly focus on functional contributing factors as time period in hundreds of days (days/100), average daily vehicular traffic in both directions, in vehicle/day, mean monthly precipitation, in mm/month and surface material property which is plasticity index (PI) of surfacing material in % , absolute value of grade in percent, percentage of surfacing material passing the 0.074 mm sieve, , and radius of horizontal curvature and the developed a model gave good correlation with the surfacing material. The studies also said that, due to weak forces binding the gravel wearing course, all gravel roads will lose their surfacingmaterials with time. The model results of the studies indicate that plastic property of surfacing material is negatively correlated with gravel loss and Traffic, precipitation and gradient of the roads are positively correlated to gravel loss.

To determine the cost-effective solutions for the provision of low volume roads it is important to understand the mechanics of how the road deteriorates. As explained in [1] deterioration of the existing unpaved low volume roads in Ethiopia is governed by the type of material used on the surface (gravel to soil); the strength of the underlying soil (soft, erodible and/or expansive), the type and action of traffic (heavy vehicle to pedestrian) and probably most importantly, the influence of the road environment. The road environment includes the interaction between the different environmental factors and the road structure. Some of these factors are uncontrollable, such as the interacting influence of climate (wind, rainfall and intensity), local hydrology and drainage, terrain and gradient. Collectively, these will influence the performance of the road and the design approach needs to recognize such influence by providing options that minimize the negative effects. Others factors, such as the construction and maintenance regime; safety and environmental demands; and the extent and type of traffic are largely controllable and can be more readily built into the design approach. The typical road environment factors were listed as in figure 6.

Figure 6 Framework for sustainable provision of low volume roads: source [1]

Figure 6 explains the constituents of road environment, lack of well consideration of factors may also lead to Surface material lost. Surface material is lost from the unsealed road is surface through the action of rain, traffic wear, and as dust. Surface material loss and dust may influence other environmental considerations.But if surface material loss is mainly due to material property, study of [21] recommends the cement stabilization. during the cement stabilization, the existing unpaved road section was pulverized to a depth of almost 30 cm and subsequently blended with 5% cement by weight using road reclaiming equipment. The surface was then covered with a double chip seal. This was to provide stability while still maintaining the appearance of a gravel road. But still this may not be economical option for developing countries.

As it was clearly said, however low volume roads (gravel roads in this study case) carries few numbers of vehicles, they cover largest number of transportation system and the vehicle loads may be very high due to the transportation of agricultural outputs. In addition to this this were exposed to variation of environmental weather condition. This will result in surface material deteriorations.When the surface material lost, the abilityto maintain the ideal profile will also be lost. The slope and profile of gravel road segment fails from time to time.

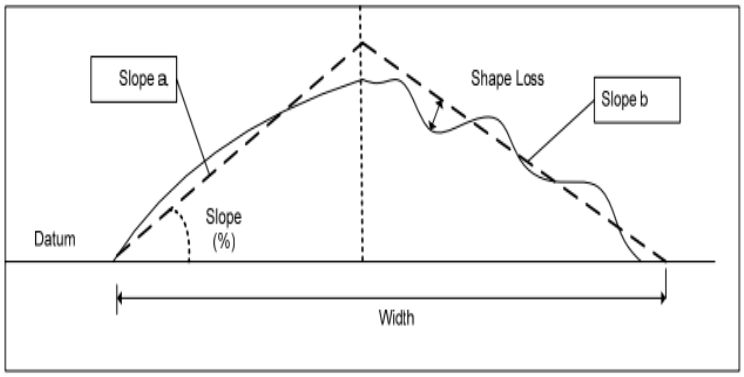

Figure 7. Definition of slope and shape indices (source [15])

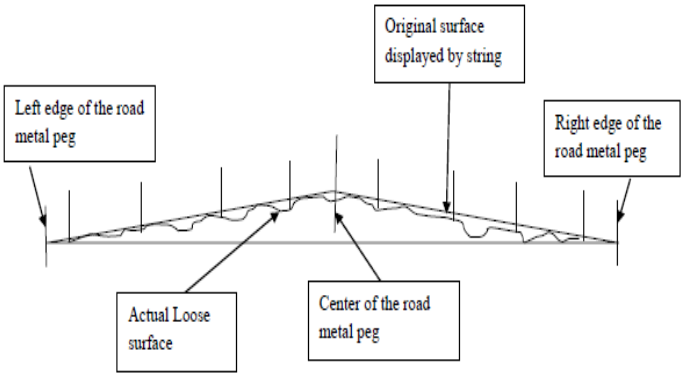

Figure 8. Detail description of surface material loss data collection

So that gravel roads must keep in good health condition. Existing technical information on materials, surface stabilization, and surfacing design must be appropriately applied directly to gravel and also earth road situations. Frequent maintenance by grading blading to maintain Roughness, rutting or profile, resurfacing, drainage protection and but because, Poor riding quality and a poor draining surface cannot be addressed through the blading, drainage passage preparation must be appropriately applied.

As stated in [10] Erosion is the loss of surfacing material caused by rainfall. The ability of a surfacing material to resist erosion depends on the shear strength which directly related to the cohesion, as the normal stress is equal to zero under the conditions at which the water flow occurs. If the shear strength of the material is less than the tractive forces induced by the water flowing over the material, material grains will become detached and may washed by erosion. Finer grained materials with minimal coarse aggregate are particularly susceptible to erosion. However, those with a relatively high plasticity compared to finer materials may resist erosion which becomes slippery in wet season.

The result of erosion is run-off channels when occurring transversely, result in high roughness and dangerous conditions, and when occurring longitudinally on grades form rutting. Associated with this road defect it results in significant surface material loss. But the erosion can be prevented by:

- Increasing the shear strength of the wearing course material by improving the grading of the material. Good compaction also increases the shear strength by improving the granular interlock and reduce material permeability.
- Decreasing the shear stresses induced by the flow of water by retarding the rate of flow by using metre-drain and diversions. This is best done by decreasing the grade and the cross-fall and ensuring that the length of the flow path of the water is minimized. The cross-fall should be greater than the longitudinal grade up to a maximum of 5 percent in order to remove the water to the side and prevent it from flowing down the full length of the grade and building up speed. For longitudinal grades in excess of 5 percent, the shear strength of the wearing course requires improvement. Erosion can be expected on most roads with grades or cross-falls greater than about 5 percent, unless preventions are taken.

Erosion of the wearing course results in a change in the thickness of the material as various fractions of the material are selectively removed during erosion and result in gravel loss.

2.5 WaterMaintenance Activities

Maintenance is the range of activities necessary to keep a road and associated road structures in an acceptable condition for road users. For Low Volume Roads, maintenance can be summarized as, to Keep the road surface in good condition (for example, repair ruts and potholes), to maintain the road surface camber to shed water to the side of the road, and to maintain the drainage system to safely lead water away from the road.

According to Low Volume Road Maintenance Booklet [22], from the moment that a road is constructed or upgraded, it will deteriorate due to the effects of weather and traffic. Maintenance is required to be carried out from time to time to restore its condition to be close to its as constructed state. If maintenance is not carried out the road will continue to deteriorate making passage increasingly difficult, uncomfortable and expensive to road users. The road may even become impassable for part or all of the year. So that Maintenance can be seen as correcting defects. In practical terms it is useful to identify and quantify the defects, and then arrange the necessary maintenance to be carried out. In this section the study tried to discuss the type of maintenance activities on road sides, road surfaces and drainage structures.

a) Road sides Maintenance activities

These are the maintenance activities that are likely to be required on a road link every year. This task may be carried out manually.

- ✓ Clearing the Trees and bushes growing on roadside
- ✓ Shoulder Blading or evening works of uneven shoulders due to drainage.
- ✓ Planting grass and trees around the road to protect the erosion.
- ✓ Rehabilitation works of uneven or eroded shoulder

b) Drainage Maintenance activities

These are the among the regular maintenance categories of maintenance activities that are likely to be required on a road link every year. This task may be carried out manually Such as

- ✓ Clearing the culverts and ditches
- ✓ Repairing the erosion damages of ditch slopes by selected fill or rocks
- ✓ Using gabion structures to protect the sides or slopes of ditches.

c) Road surface Maintenanceactivities

These are the among the regular maintenance categories of maintenance activities that are likely to be required somewhere on a road link every year. This task may be carried out manually Such as

- ✓ Compacting or reshaping road surface to maintain the defects like Road surface potholed, ruttedor uneven
- ✓ Slightly or heavily blading gravel road surface to maintain the Road Surface rutted or uneven
- ✓ Repairing by using Repair Selected Material or CrushedAggregate
- ✓ Blading Gravel Road lightly or heavily for rutted or uneven Road Surface

3. CONCLUSIONS AND RECCOMENDATIONS

The laboratory study was carried out to stabilize black cotton soil (expansive soil) using bagasse ash to be conducted on atterberg test to get the improved plasticity index, compaction test to increase maximum dry density and to decrease optimum moisture content of the soil, unconfined compression strength to improve bearing capacity of the soil, California bearing ratio to modify the penetration strength of subgrade soil of foundation materials.

It is convenient to identify defects and apply maintenance to correct the road surface deterioration. During the gravel and earth road construction road side ditch's and drainage way must be strongly applied because of most of the gravel and earth road failure is

due to lack of road side ditches. The road surface must be constructed with good slope to drain the rain water into ditches. Good surface materials which could with stand the variation of weather condition and vehicular load must be selected. Traffic design has to be done in with well traffic growth rate consideration because traffic numbers and type is taken as the main factor affecting unpaved road loss. As overloading can highly fasten the deterioration rate, the agricultural and marketing products has been well study and also forecasted. The gravel and also earth road must be located in good geometry which suitable for further maintenance activities. The road environment must be regularly and periodically maintained.

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