Construction and Designing of Highways

Jyotiyadav[1] | Nirkalash yadav[2] | Vishal kumar[3] | Dipeshkumaryadav[4]

[1, 2. 3.] UG Students, Department of Civil Engineering, Godavari Institute of Engineering and Technology (A), Rajahmundry, Andhra Pradesh, India.

[4]Assistant Professor, Department of Civil Engineering, Godavari Institute of Engineering and Technology (A), Rajahmundry, Andhra Pradesh, India.

Abstract: Nowadays is the world of modern. people is increasing their standards due to the infrastructure. transportation is the major infrastructure which connects all over the world. for transportation facilities road is necessary

Roads are one of the most important parts of the infrastructures and they play a key role in development of the society all around the world. Despite having a crucial part in national economy, road network systems imply high economic burdens on the road agencies. In order to keep the quality of the roads above an acceptable level, large amount of investments for rehabilitation and maintenance activities are necessary. The case of not being able to provide those funds will result in a poor road's safety and operational condition.

Life Cycle Cost (LCC) is the total discounted cost for construction, operation, maintenance,and disposing of a facility during its defined life time. Life Cycle Cost Analysis (LCCA) is an economic evaluation method to obtain the total cost of construction, operation,maintenance, and demolition for a property during its life time [8]. By providing cost estimation over the life time of a project for initial construction cost and all the related costs for rehabilitations and maintenances, LCCA helps the designers, road administrations, and contractors with choosing the most economically efficient design for the roadways. Thus LCCA can be used as a basis for more optimized investments [1]. The American Association of State Highway and transportation Officials of 1986 and 1993 describe the different costs that must be considered in LCCA. The agency and the user costs associated with pavement projects and also economic evaluation methods and discount rate is also discussed in the guide [2]. The center for Transportation Research (CTR) developed the Flexible Pavement System, a methodology and software to compare the total design life costs for different alternatives |4] In order to perform LCC on roads a prediction on the life time of the road, corresponding thicknesses of structural layers as well as the eventual rehabilitations are required. To calculate the asphalt design thickness for an assumed number of years, the Calibrated Mechanistic design (CM) model can be used. This study aimed to develop an approach for performing comparative LCCA in order to find the most economical design alternative in terms of the total cost during the pavement design life. In this approach a LCCA was construction innovation, manufacturing innovation, Road construction, case study, project management,performed based on design predictions by the CM flexible pavement design model.

KEYWORDS:.*construction innovation, manufacturing innovation, Road construction, case study, project management,*

DOI of the Article: https://doi.org/10.46501/GIETCE07

Available online at: https://ijmtst.com/iccecam2021.html

As per UGC guidelines an electronic bar code is provided to seure your paper

To Cite this Article: Jyotiyadav; Nirkalash yadav; Vishal kumar and Dipeshkumaryadav. Construction and Designing of Highways. *International Journal for Modern Trends in Science and Technology* 2021, *7*, pp. 46-62. https://doi.org/10.46501/GIETCE07

Article Info. Received: 18 May 2021; Accepted: 25 June 2021; Published: 30 June 2021

I. INTRODUCTION

1.1 ROAD

Development of a country depends on the connectivity of various places with adequate road network. Roads are the major channel of transportation for carrying goods and passengers .They play a significant role in improving the socio-economic standards of a region. Roads constitute the most important mode of communication in areas where railways have not developed much and form the basic infra-structure for the development and economic growth of the country. The benefits from the investment in road sector are indirect, long-term and not immediately visible. Roads are important assets for any nation. However, merely creating these assets is not enough, it has to be planned carefully and a pavement which is not designed properly deteriorates fast. Nepal is a small country having huge resource of materials.

If these local materials are used properly, the cost of construction can be reduced. There are various type of pavements which differ in their suitability in different environments. Each type of pavement has its own merits and demerits. Despite a large number of seminars and conference, still in Nepal, 98% roads are having flexible pavements. A lot of research has been made on use of Waste materials but the role of these materials is still limited. So there is need to take a holistic approach and mark the areas where these are most suitable .Nepal has one of the largest road networks in the world (over 3 lakh km at present) For the purpose of management and administration, roads in Nepal are divided into the following five categories:

1.National highways.
2.State highways.
3.Major district roads.
4.Other district roads.
5.Village roads.

The National Highways are intended to facilitate medium and long distance inter-city passenger and freight traffic across the country. The State Highways are supposed to carry the traffic along major centres within the State. Other District Roads and Village Roads provide villages accessibility to meet their social needs as also the means to transport agriculture produce from village to nearby markets. Major District Roads provide the secondary function of linkage between main roads and rural roads.

WHAT IS ROAD OR PAVEMENT?

Pavement or Road is an open. generally public way for the passage of vehicles, people, and animals. Pavement is finished with a hard smooth surface. It helped make them durable and able to With stand traffic and the environment. They have a life span of between 20-30 years. Road pavements deterior ate over time due to The impact of traffic, particularly heavy vehicles. Environmental factors such as weather, pollution.

PURPOSE

Many people rely on paved roads to move themselves and their products rapidly and reliably.

FUNCTION

One of the primary functions is load distribution. It can be characterized by the tire loads,
tire configurations, repetition of loads, and distribution of traffic across the pavement, and vehicle speed.
Pavement material and geometric design can affect quick and efficient drainage. These eliminating moisture problems such as mud and pounding

(puddles). Drainage system consists of Surface drainage: Removing all water present on the pavement surface, sloping, chambers, and kerbs .Subsurface drainage: Removing water that seep into or is contained in the underlying subgrade.

TYPES OF PAVEMENTS

There are various types of pavements depending upon the materials used; a briefs description of all types is given here.

FLEXIBLE PAVEMENTS

Bitumen has been widely used in the construction of flexible pavements for a long time. This is the most convenient and simple type of construction. The cost of construction of single lane bituminous pavement varies from 20 to 30 lakhs per km in plain areas. In some applications, however, the performance of conventional bitumen may not be considered satisfactory because of the following reasons In summer season, due to high temperature, bitumen becomes soft resulting in bleeding. rutting and segregation finally leading to failure of pavement.

In winter season, due to low temperature, the bitumen becomes brittle resulting in Cracking. cravelling and unevenness which makes the pavement unsuitable for use.

In rainy season, water enters the pavement resulting into pot holes and sometimes total removal of bituminous layer In hilly areas, due to sub-zero temperature, the freeze thaw and heave cycle takes place. Due to freezing and melting of ice in bituminous voids, volume expansion and contraction occur. This leads to pavements failure. The cost of bitumen has been rising continuously. In near future, there will be scarcity of bitumen and it will be impossible to procure bitumen at very high costs.

RIGID PAVEMENTS

Rigid pavements, though costly in initial investment, are cheap in long run because of low maintenance costs. There are various merits in the use of Rigid pavements (Concrete
pavements) are summarized below:

Bitumen is derived from petroleum crude, which is in short supply globally and the price of which has been rising steeply. India imports nearly 70% of the petroleum Crude. The demand for bitumen in the coming years is likely to grow steeply, far
Out stripping the availability. Hence it will be in India's interest to explore alternative binders. Cement is available in sufficient quantity in India, and its availability in the future is also assured. Thus cement concrete roads should be the obvious choice infuture road programmes.Besides the easy available of cement, concrete roads have a long life and arepractically maintenance-free.

Another major advantage of concrete roads is the savings in fuel by commercialvehicles to an extent of 14-20%. The fuel savings themselves can support a largeprogramme of concreting.Cement concrete roads save a substantial quantity of stone aggregates and this factormust be considered when a choice pavements is made, Concrete roads can withstand extreme weather conditions wide ranging ,temperatures, heavy rainfall and water logging.Though cement concrete roads may cost slightly more than a flexible pavementinitialy, they are economical when whole-life-costing is considered. Reduction in the cost of concrete pavements can be brought about by developing semi-self-compacting concrete techniques and the use of closely spaced thin joints. R&D efforts should be initiated in this area.

TYPES OF CONCRETE PAVEMENT

1. PLAIN CONCRETE OR SHORT PAVEMENT SLABS

This type of pavement consists of successive slabs whose length is limited to about 25 times the slab thickness. At present it is recommended that the paving slabs not be made longer than 5,even if the joints have dowels to transfer the loads. The movements as a result of fluctuations in temperature and humidity are concentrated in the joints. Normally, these joints are sealed to prevent water from penetrating the road structure. The width of the pavement slabs is limited to a maximum of 4.5 m.

2. REINFORCED CONCRETE

Continously reinforcement concrete

Continuously reinforced concrete pavements are characterised by the absence of transverse joints and are equipped with longitudinal steel reinforcement. The

diameter of the reinforcing bars is calculated in such a way that cracking can be controlled and that the cracks are uniformly distributed (spacing at I to 3 m). The crack width has to remain very small, i.e. less than 0.3 mm.

Reinforced pavements slabs

Reinforced concrete pavement slabs are almost never used., except for inside or outside industrial floors that are subjected to large loads or if the number of contraction joints has to be limited.

Steel fibre concrete

The use of steel fibre concrete pavements is mainly limited to industrial floors. However, in that sector they are used intensively. For road pavements steel fibre concrete can be used for thin or very thin paving slabs or for very specific application.

TYPES OF ROADS

BASED ON THE LOCATION AND FUNCTION.

1.National highways
2.state highways
3.District highways
4.Rural highways

BASED ON THE CONSTRUCTION MATERIALS

1.Earthern roads
2.Gravel roads
3.Concrete roads
4.Bituminous roads
5.Murrum roads
6.Kankar roads
7.WBM roads

BASED ON TRAFFIC VOLUME

1.Light traffic
2.Medium traffic
3.High traffic

DIFFERENT MODE OF TRANSPORTATION

The movements of passengers and goods from one place to another place is known as transportation.

There are 3 modes of transportation.
1.Road transportation
2.Water transportation
3.Air transportation

- The movement of vehicles on road such as bus,car,bike,truck etc. is known as road transportation.
- The movement of ships,boats on water is known as water transportation.
- The movement of goods or people on aeroplane,helicopter,jet planes etc which is fly in air is known as air transportation

OBJECTIVES OF ROAD

- The alignment should be such that it is easy to construct and maintain the road with minimum problems.
- The road should be more strength, durable and resistivity.
- The road should be economical in its cost of construction, maintenance and traffic operation.
- The road should have good natural aspects.
- The road should be safe for traffic operation.

CHARACTERISTICS OF ROAD

- A highway is any public or private road or other publicway on land.
- It is used for major roads.
- Road is a wide way leading from one place to another, especially one with a specially prepared surface which vehicles can use.
- Road should be gravel road, mud road RCC road, bitumenous road etc.
- Road gives quick and easy transportation of men, machineries, materials etc.
- Construction and maintenance of road should be economic.
- Road transport is a basic need in case of fire, health and police protection.

LITERATURE REVIEW

- **Kulratnatuladhar**- He was the first chief engineer of nepal who opens the tribhuvan highway and he said that The amount of congestion and its documentation increase is closely related to similar trends in population growth.
- **Rajendra raj sharma** - A transportation study showed the overcrowding of transportation corridors during peak travels time doubled in 77 districts in Nepal. To

control the traffic extend or widening of road and new road is required.

Baburambhattarai - Highways construction struggles to produce sufficient capacity to address the demands of growth.

Subodh das - Road capacity has changed little over time compared with demand.

Nishatripathee -This increased use results in growing congestion, which in turns fuel public discontent.

of available data. Gould (2005) defined estimate as an appraisal, an opinion, or an approximation as to the cost of a project prior to its actual construction. According to Jelen et al. (1983), estimating is the heart of the

Ahuja et al. (1994) state that estimating is the primary function of the construction industry; the accuracy of cost estimates starting from an early phase of a project through the tender estimate can affect the success or failure of a construction project. They also state that many failures of construction projects are caused by inaccurate estimates. A cost estimate establishes the base line of the project cost at different stages of development of the project. As Hendrickson et al. (1989) point out, a cost estimate at a given stage of project development represents a prediction provided by the cost engineer or estimator on the basis cost engineer's work and consequently it has received appropriate attention over the years. Holm et al. (2005) lists several reasons for making estimate, including: Feasibility studies• Selection from alternate design• Selection from alternate investment• Appropriation of funds• Presentation of bids and tenders• A number of cost prediction models have been developed.

SCOPEANDOBJECTIVE

The aim of this project is follows;

The alignment should be such that it is easy to construct and maintain the road with minimum problems.

The road should be more strength, durable and resistivity.

The road should be economical in its cost of construction, maintenance and traffic operation.

The road should have good natural aspects.

- The road should be safe for traffic operation.

MATERIALSANDMETHODOLOGY

MATERIALS

Concrete is widely used in domestic, commercial, recreational, rural and educational

construction. Communities around the world rely on concrete as a safe, strong and simple building material. It is used in all types of construction; from domestic work to multi-storey office blocks and shopping complexes. Despite the common usage of concrete, few people are aware of the considerations involved in designing strong, durable, high quality concrete.

There are mainly three materials used primarily-

1.Cement

2.Sand

3.Aggregate

CEMENT

Cement is a binder, a substance that sets and hardens independently, and can bind othermaterials together. The word "cement" traces to the Romans, who used the term calcenticium to describe masonry resembling modern concrete that was made fromcrushed rock with burnt lime as binder. The volcanic ash and pulverized brick additives that were added to the burnt lime to obtain a hydraulic binder were later referred to as cementum, cimentum, cement, and cement.

Cements used in construction can be characterized as being either hydraulic or non-hydraulic. Hydraulic cements (eg., Portand cement) harden because of hydration, achemical reaction between the anhydrous cement powder and water. Thus, they can harden underwater or when constantly exposed to wet weather. The chemical reaction results in hydrates that are not very water-soluble and so are quite durable in water. Non-hydraulic cements do not harden underwater; for ex ample, slaked limes harden by reaction with atmospheric carbon dioxide.

The most important uses of cement are as an ingredient in the production of mortar inmasonry, and of concrete, a combination of cement and an aggregate to form a strongbuilding material.

4 TYPES OF CEMENT:

Portland cement

Portland cement is by far the most common type of cement in general use around the world.This cement is made by heating limestone (calcium carbonate) with small quantities of other materials (such as clay) to 1450 C in a kiln, in a process known as calcinations, where by a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which is then blended with the other materials that have been included in the mix. The resulting hard substance, called clinker, is then ground with a small amount of gypsum into a powder to make Ordinary Portland Cement, the most commonly used type of cement (often referred to as OPC). Portland cement is a basic ingredient of concrete, mortar and most non-specialty grout. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement, and water. As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural (load bearing) element. Portland cement may be grey or white.

Portland fly ash cement

It contains up to 35% fly ash. The fly ash is pozzolanic, so that ultimate strength is maintained. Because fly ash addition allows lower concrete water content, early strength can also be maintained. Where good quality cheap fly ash is available, this can be an economic alternative to ordinary Portland cement.

5 Portland pozzolana cement

Its includes fly ash cement, since fly ash is a pozzolanic , but also includes cements madefrom other natural or artificial pozzolans. In countries where volcanic ashes are available.

Portland silica fume cement

Addition of silica fume can yield exceptionally high strengths, and cements contain ing 5-20% siica fume are occasionally produced. However, silica fume is more usually added toPortland cement at the concrete mixer

SAND

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The composition of sand is highly variable, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non- tropical coastal settings is silica (silicon dioxide, or SiO,), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish. t is, for example, the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years like the Caribbean.

AGGREGATE

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and Portland cement, are an essential ingredient in concrete. For a good concrete mix. aggregates need to be dean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into two distinct categories-fine and coarse. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 38-inch (9.5-mm) sieve. Coarse aggregates are any particles greater than 0.19 inch (4.75 mm), but generally range between 3/8 and 1.5 inches (9.5 mm to 37.5 mm) in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder Natural gravel and sand are usually dug or dredged from a pit, river, lake, or seabed. Crushed aggregate is produced by crushing quarry rock, boulders, cobbles, or large-size gravel. Recycled concrete is a viable source of aggregate and has been satisfactorily used in granular sub bases, soil-cement, and in new concrete. Aggregate processing consists of crushing, screening, and washing the aggregate to obtain proper clean lines and gradation. If necessary, a benefaction process such as jigging or heavy media separation can be used to upgrade the quality.

Once processed, the aggregates are handled and stored in a way that minimizes segregation and degradation and prevents contamination. Aggregates strongly influence concrete's freshly mixed and hardened properties, mixture proportions, and economy. Consequently, selection of aggregates is an important

process. Although some variation in aggregate properties isexpected, characteristics that are considered when selecting aggregate include

1.grading
2.durability
3.particle shape and surface texture
4.abrasion and skid resistance
5.unit weights and voids
6.absorption and surface moisture.

Grading refers to the determination of the particle-size distribution for aggregate. Gradinglimits and maximum aggregate size are specified because grading and size affect the amount of aggregate used as well as cement and water requirements, workability.

FINE AGGREGATE:

Fine aggregate shall consist of sand, or sand stone with similar characteristics orcombination thereof. it shall meet requirements of the State Department of Transportation of Uttar Pradesh, Section 501.3.6.3 of the Standard Specifications for Highway and Structure Construction, current edition.

COARSE AGGREGATE:

Coarse aggregate shall consist of dean, hard, durable gravel, crushed gravel, crushedboulders, or crushed stone. t shall meet the requirements of the State Department ofTransportation of Uttar Pradesh , Section 501.3.6.4 of the Standard Specifications forHighway and Structure Construction, current edition

PROCEDURE TO CONSTRUCT PAVEMENTS

During construction of a cement concrete pavement, various steps are taken as below-

survey of proposed work is done by experienced engineers or by any expert of survey.

site survey includes geographical details, soil properties and site investigation.

after survey, a team of experienced engineers and architecture prepare detailed planof work with the help of various software's.

after that a engineer prepares detailed estimate of proposed work and also prepares aestimate regarding equipments required and labours requirements.

now excavation is done with the help of automatic machines and then a equipment isused to cut nearby trees and root removal process.

and after these construction of soil sub grade , base coarse and then construction ofconcrete slab is done.

PREPARATION OF THE SUB- GRADE OR BASE COARSE

The road sub grade has to be prepared carefully, in order to realize everywhere a pavement structure of an adequate and uniform thickness. This allows to provide a homogeneous bond between the concrete slab and its foundation which is important for the later behaviour of the pavement structure.

For roads with a base, drainage of the water must be provided. Mud, leaves, etc. have to be removed.When the base is permeable, it should be sprayed with water in order to prevent the mixing water from being sucked out of the concrete.

However, if the base is impermeable (e.g. if the concrete is placed on a watertight asphaltconcrete interlayer) it can be necessary under warm weather conditions to cool down thislayer by spraying water on the surface.

The following points are important for roads without a foundation:

1.Drainage of all surface water,

2.Good compaction of the sub grade

3.Filling and compaction of any ruts caused by construction traffic;

4.It is forbidden to level the sub grade by means of a course of sand. If the sub gradehas to be levelled, it is advisable to do this by using a granular material: either slag orcoarse aggregate e.g. with a grain size 0/20;

5.Provide an additional width of the sub grade for more lateral support.

It must always be avoided that water is sucked from the cement paste into the substructure or the base. This can be accomplished by either moderately moistening the sub grade, or by applying a plastic sheet on the substructure of the pavement. The latter work must be done with care, to prevent the sheet from tearing or being pulled loose by the wind.

PROPORTIONING:

The following table sets forth the master limits of the job mix for the several grades ofconcrete, and designates the quantities of materials and relative proportions for each grade of concrete. For Air-Entrained High-Early-Strength Concrete, as required or permitted

when High-Early-Strength Cement is used, the proportions shall be as given in the table. The quantities of aggregates set forth in the tabulations are for oven dry materials having a bulk specific gravity of 2.65. For aggregates having a different specific gravity, the weights shall be adjusted in the ratio that the specific gravity of the material used bears to 2.65.

7

Maximum size coarse aggregate	Cement	Sand (wet)	Coarse aggregate (wet)	water
3/8	1	2.5	1.5	1/2
1/2	1	2.5	2	1/2
3/4	1	2.5	2.5	1/2
1	1	2.5	2.75	1/2
1 1/2	1	2.5	3	1/2

METHODOLOGY

Following extensive data collection, a multi criteria analysis was used to make the final selection of the road from the long list of roads to be the short list.

ENGINEERING STUDY

1.scope
2.surveys and investigation
3.applicable standards
4.pavement design standards
5.bridge design standards.
7.safeguards.

SURVEYS AND INVESTIGATION

Topographic surveys
Hydrological study
Road condition survey
Geological assessment
Pavement condition

Highway Alignment and Engineering Survey
Highway Alignment
Introduction
Requirements of Highway Alignment
Factors Controlling Highway Alignment
Engineering Survey and its Stages
Route Location Process

Engineering Survey: Map Study, Reconnaissance, Preliminary and Detailed Survey

Introduction:

The position of the center line of the highway in the ground is called highway alignment. Highway alignment includes horizontal alignment and vertical alignment. The projection of highway alignment in horizontal plane is called horizontal alignment and the projection in vertical plane is known as vertical alignment. Alignment must be selected in such a way that the overall cost during construction, operation and maintenance is minimum. Road design outputs are in the form following drawings:

Plan:

It Includes centre line, structures, Right of Way (ROW), carriage way, shoulders, side drain.

Longitudinal Profile:

Soil Type, Depth of cut, Height of Fill, Side drain (Information on from
which chainage to which chainage), Direction of flow in the drain.

Cross section:

Ground Level, Formation Level, Super elevation, Area of Cutting and Area of
filling thus computation of the volume and then cost estimation can be done.

Requirements of Highway Alignment:

The ideal alignment must have the following requirements:

Safe (S))
Easy (E)
Short (S)
Economical (E)
Comfort (C)

The requirements can be memorized as SESEC.

Safe: The alignment need to be safe during construction, operation and maintenance especially at slopes, embankments and cutting.

Easy: The construction materials if present at the place of construction makes the construction easier. Similarly,

it should be easy during the operation of vehicles with easy gradients and curves.

Short: The distance between the initial and final point need to be short so as to reduce the construction cost.

Economical: The alignment should be economical during construction, operation, and
maintenance. However, if the construction turned out to be economical, the gradient may not be easy which in turns increases the cost of operation and maintenance. Similarly, if the vehicle operation 1s taken under consideration and is made economical, the construction cost becomes higher as the gradient and curves need to be easy.

Comfort: The alignment should be fixed such that it provides comfort to the drivers and the passengers.

Factors Controlling Highway Alignment:

Governmental Requirement: As the road project needs a large investment, the government should be clear about the requirement of the road (when, what, how and why
to construct).

Obligatory Points: Obligatory points determine the highway alignment. They are further divided into positive obligatory points and negative obligatory points.

Positive Obligatory Points: These are those points through which the alignment should pass.

Existing Road: The alignment should be fixed such that the newly constructed road should link to the existing road. It reduces the cost of construction.

IntermediateTown: If there is the possibility of a straight road between point A and B and there lies the intermediate town at C as shown, then the A road need to link the intermediate town reducing the change in highway alignment.

Bridge site/Existing Bridge: The road linking with the bridge must not be curved and to include the bridge in the road portion, the highway alignment may be changed.

Mountain: When the road has to cross a row of hills, mountain pass may be the suitable
alternative.

Negative Obligatory Points: These are those points through which the alignment should
not pass.

1.Valleys, ponds, and marshy land need to be avoided.

2.Religious places are linked up with the human sentiment so cannot be destroyed forfixing the road alignment.

3.Costly structures present in the way of alignment should be considered and the roadalignment should be fixed such that it won't destroy those costly structures as the valueof compensation for such structures will be more.

4.Conservation areas and restricted zones.

5.Densely populated area.

6.The road should not be within the boundary of the country.

Traffic (Type, amount and flow pattern):

The alignment should be according to the traffic amount and flow pattern. The number of
lanes can be determined as:
Number of lanes = Traffic Volume / Traffic Capacity.

Geological Condition:

Geologically stable hill slope must be considered while selecting the highway alignment.

Geometric Design:

Various factors regarding geometric design as the radius of curve, sight distance, gradient
determines the highway alignment.

Availability of construction materials and labor:

The construction works become easier and economical when the construction mater
3/7 near the place of highway alignment.

Economy:

The construction, operation, and maintenance work should be economical. So, highway
alignment is selected keeping these things in mind.

Other Considerations:

Drainage: The alignment needs to be fixed such that the number of cross drainage
structures are less.

Political: Alignment need to be within the allocated territory.

Monotony: Setting the straight alignment leads to monotonous driving. So a small bend is provided to make the driver aware and alert. The roads are designed as forgiving roads.

Special Consideration in Hill Roads:

Stability: The road should be aligned with the hill side that is stable. Excessive cutting and filling may effect on their stability.

Drainage: Adequate drainage facility need to be provided across the road and the number of cross drainage structures need to be less during construction.

Geometric Standards: Geometric design parameters also effect on the construction of
roads. Minimizing steep gradient, hairpin bends and needless rise and fall.

Resisting Length: The ineffective rise and excessive fall should be minimum.

Engineering Survey and its stages:

Map Study

Reconnaissance

Preliminary Survey

Final Location and Detailed Survey

Structure of Route Selection Process

Sequential Structure of Route Location Process

Region> Bands (8-16km)> Corridors (3-10km)> Route Strips (1-1.5km) > Alignments
(30-50m)

The beginning and the end point is selected and the region is defined. The region is further studied in search of broad bands which are 8-16km wide. From these broad bands, the corridor is studied then the route strips and possible alignments are found out.

Engineering Surveys: Map Survey. Reconnaissance. Preliminar Survey and Detailed Surveys:

Map Study:

The study of the topographical map is done to find out the possible routes of the road. Following information are obtained from the map study:

1. Alignment avoiding valley, ponds, lakes.
2. When the road has to cross a row of hills, mountain pass may be the suitable alternative.
3. Approximate location of the bridge site.

Reconnaissance Survey

Simple Survey Instruments are used in the reconnaissance procedure.

Following are the information obtained from the reconnaissance survey:

1. Valley, pond, lakes and other features that were not present in the topographical map.
2. A number of cross drainage structures, High Flood Level (HFL), Natural Ground Level.
3. Values of the gradient, the length of gradients and radius of the circular curve.
4. Soil type along the routes from field identification tests and observation of the geological features.
5. Sources of construction materials.

Preliminary Survey:

Sophisticated Survey Instruments are used during the preliminary survey.

Objective of the Preliminary Survey are listed below:

1. To collect necessary physical information and details of topography, drainage, and soil.
2. To compare different proposal in view of the requirement of good alignment.
3. To estimate the quantity of earthwork.
4. To finalize the best alignment.

Methods of Preliminary Survey:

Conventional Approach

Modern Rapid Approach

Conventional Method:

The procedure for the conventional approach are listed below:

Traverse: The traverse is run from the starting point to the end point by setting out various control points. Both primary traverse and secondary traverse may need to be run.

Leveling work: The leveling work is carried out along the centre line or the proposed
road. The leveling work is used to estimate the volume of the earthwork. Both L-section
and X-section are carried out.

Topographical features: All geographical and man-made features are survey and plotted
which are along the traverse and for a certain width on either side.

Drainage Studies and Hydrological data: The number of cross drainage structures are
estimated during the preliminary survey.

Soil Survey: The soil survey is conducted in working out details of earthwork, slope, and
stability of materials, subsoil and surface drainage requirements and the type of the
pavement requirements.

Material Survey: The location of construction materials need to be known.

Traffic Survey: Survey regarding the number of lanes, roadway width, and pavement
design need to be done.

Determination of final centre line: After completion of all the above mention steps and
calculating the amount of earthwork, the final centre line is determined.

Modern rapid approach:

The procedure of the Modern rapid approach are listed below as:

1. Taking aerial photographs with required lateral and longitudinal overlaps.
2. These photographs are then examined under stereoscopes and control points are selected for the establishment of the traverse.
3. The spot levels and contour lines may be obtained from the stereo pair observations.
4. Photo interpretation method is used to grab information on the geological features, soil
conditions, drainage requirement, etc.

Final Location and Detailed Survey:

Location: The centre line of the road which is finalized in the preliminary survey is then located in the field by establishing the centre line. Major and minor control points are then established on the ground and the central pegs are driven, checking the geometric design criteria. If necessary, the modification of the final location can be altered.

Detailed Survey:

1. Temporary Bench Marks (TBM) are fixed at all under pass structures and drainage structures.

2. Levels along the final centre line should be taken with great importance as these data are required for vertical alignment, eath work calculation, and drainage details.

3. A detailed survey is carried out to enable drawing the soil profile up to the depth of 1.5
3m below the Ground Line and twice the height of the finished embankment in the case of the high embankment.

The data during the detailed survey should be elaborated and completed for the preparation of the plans, designing, and estimation of the project

RESEARCH METHODOLOGY

This study is based on both primary and secondary data. Primary data will be collected through a field survey. Data such as road design, cost estimates, bill of quantity, running bills, final bills, and work completion reports were collected for study and field verification as well and testing has been done in fields.

Suitable indicators and parameters for the study purposes were formulated, and a comparative analysis of the acquired data has been done in this study. Similarly, a suitable questionnaire survey regarding health and safety management was prepared and conducted during the field visits. The degree of effective implementation for each performance indicator obtained was multiplied with a certain coefficient. The weighted degree of all the individual evaluated criteria was summed up to get the
overall degree of effectiveness of the implementation of road construction work.

Sampling

The sampling of the roads was conducted as per the use, length, serviceability, area covered, and beneficiary population. The total number of wards was randomly clustered and the sample of roads was taken using the convenience method of sampling within the
selected wards having more quality issues publicly.

Data Collection

The primary data were collected through field verification and secondary data through project document analysis. In field verification, technical, health, and safety parameters as per the approved specification will be checked.

Primary Data Collection

Primary data were collected through field visits using the prepared questionnaire and verification of the implementation in the field.

Secondary Data Collection

Secondary data were collected through documents from the Metropolitan City Office and related publications. Similarly, the secondary data were collected through different project documents, reports, journals, and books, which are listed below:

DOR Norms and Specifications

DOLIDAR Norms and Specifications

Nepal Road Standard 2070

Quality control handbook for rural road construction and maintenance (Volume I)

Municipal Acts and regulations

Sub-Project Documentation Reports from the MetropolitanCity Planning section

Data Analysis

The outcome of data collected from the field visits and questionnaire surveys were analyzed based on the formulation of different evaluation criteria. Finally, the end conclusions were drawn with certain engineering significance

.Different parameters that were chosen from

Procurements documents

Quality of works

Work progress

Financial management

Monitoring evaluation, and reporting

Communication and transparency

Environmental safeguard compliance

Details of selected roads for the

Statistical Analysis

Various statistical methods were used to meet the objectives of the study. The obtained data were analyzed with the statistical tool as correlation, table, charts, and diagrams. The analysis was carried out using the powerful Excel and SPSS software.

Regression analysis was conducted to establish the relationship between the different evaluated criteria using method of least square.

TESTS ON ROAD CONSTRUCTION

- **1.SOIL TEST**
- **2.MOISTURE CONDITION VALUE TEST**
- **3.CALIFORNIA BEARING RATION (CBR) TEST**
- **4.GROUND PENETRATING RADER (GPR)**
- **5.PENETRATION TEST ON BITUMEN**
- **6.SOFTENING POINT TEST ON BITUMEN**

SOIL TEST

1. Types of soil tests for a road construction project require the site investigation to be carried out to understand the soil profile.

2. For road construction works, the properties of soil at subgrade level are required.

3.The common soil test for road construction includes classification of soil, particle size distribution, moisture content determination, specific gravity, liquid limit and plastic limit tests.

4.Moisture content, particle size and specific gravity tests on soil are used for the calculation of soil properties such as degree of saturation.

5.The soil tests can be laboratory tests or in-situ tests

Types of soil tests for a road construction project require the site investigation to be carried out to understand the soil profile. For road construction works, the properties of soil at subgrade level are required. The common soil test for road construction includes classification of soil, particle size distribution, moisture content determination, specific gravity, liquid limit, and plastic limit tests. Moisture content, particle size, and specific gravity tests on soils are used for the calculation of soil properties such as degree of saturation. The soil tests can be laboratory tests or in-situ tests.

The moisture content of the soil test is carried out in the laboratory. It is expressed as the percentage of water in the soil to its dry mass. The moisture content in soil signifies the various properties of soil such as compaction, permeability, particle size, etc.

MOISTURE CONDITION VALUE TEST

- There is a relationship between compacting effort, moisture content and density.
- The MCV test involves testing a soil at fixed moisture content and by increasing the number of blows of a rammer, determining the compactive effort beyond which no further increase in density occurs.
- As a general guide of MCV of 8.5 is recommended as the lower limit of acceptability of a soil for compaction at its natural moisture content and difficulties in earth working can be expected when MCV drops significantly below this value.

The results of the moisture condition value test (mcv) are used for assessing and controlling the suitability of soils for earthworks. Tests at different moisture contents are termed the moisture condition calibration (mcc) and a relationship can be drawn between mcv and moisture content. There has been a growing requirement for these tests and whilst the test methods themselves are fairly well agreed the actual interpretation of the results gives rise to difficulties. The author outlines alternative ways in which results can be interpreted and puts forward explanations for these discrepancies. Various soil types are considered and graphs presented. The author suggests guidelines to follow when working with the mcv test which cover laboratory work, interpretation and reporting.

CALIFORNIA BEARING RATION TEST

- It is also called as CBR test.
- The CBR test is a penetration test used to evalute the subgrade strength of roads and pavements.
- This is the most widely used method for the design of flexible pavement.
- The CBR test involves the insertion of a 5omm diameter plunger into the ground surface at a rate of 1 mm per minute, while the load is recorded.
- Surcharge rings can be placed around the plunger to simulate an overburden.
- The load at penetration of 2.5mm and 5mm is commonly with the result from a standard aggregate.
- And the ratio given as a percentage (%).

The California Bearing Ratio(CBR) test is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture conditions. It was developed by the California Division of Highways as a method of classifying and evaluating soil- subgrade and base course materials for flexible pavements. CBR test may be conducted in remoulded or undisturbed sample. Test consists of causing a cylindrical plunger of 50mm diameter to penetrate a pavement component material at 1.25mm/minute. The loads for 2.5mm and 5mm are recorded. The aim of this test is the determination of California Bearing Ratio value of the subgrade soil.

AIM OF THE CBR TEST

Loading machine-any compression machine can operate at constant rate of 1.25mm per minute can be used. Cylindrical moulds- moulds of 150mm diameter and 175mm height provided with a collar of about 50mm length and detachable perforated base. Compaction rammer, surcharge weight-annular weights each of 2.5kg and 147mm diameter. IS sieve 20mm, Coarse filter paper, balance etc.

PROCEDURE FOR CBR TEST

Sieve the sample through 20mm IS sieve. Take 5 kg of the sample of soil specimen. Add water to the soil in the quantity such that optimum moisture content or field moisture content is reached. Then soil and water are mixed thoroughly. Spacer disc is placed over the base plate at the bottom of mould and a coarse filter paper is placed over the spacer disc. The prepared soil water mix is divided into five. The mould is cleaned and oil is applied. Then fill one fifth of the mould with the prepared soil. That layer is compacted by giving 56 evenly distributed blows using a hammer of weight 4.89kg. The top layer of the compacted soil is scratched. Again second layer is filled and process is repeated. After 3rd layer, collar is also attached to the mould and process is continued. After fifth layer collar is removed and excess soil is struck off. Remove base plate and invert the mould. Then it is clamped to baseplate. Surcharge weights of 2.5kg is placed on top surface of soil. Mould containing specimen is placed in position on the testing machine. The penetration plunger is brought in contact with the soil and a load of 4kg(seating load) is applied so that contact between soil and plunger is established. Then dial readings are adjusted to zero. Load is applied such that penetration rate is 1.25mm per minute. Load at penetration of 0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 7.5, 10 and 12.5mm are noted.

PENETRATION TEST ON BITUMEN

- Bitumen is a construction material which is used to cover the upper surface of road for better and smooth performance.
- Bitumen is applied on road in liquid form.
- Its basic principle is to determine the depth to which a needle penetrated as asphalt sample under specified conditions of load, time and temperature.
- The test is conducted under following condition-

- Load = 100g
- temperature = 25c
- time = 5sec

- The depth of penetration is measured in units of 0.1mm and reported in penetration units (e.g. if the needle penetrate 8mm, the asphslt penetration number is 80.).
- Penetration grading is based on penetration test.
- The CBR values are usually calculated for penetration of 2.5mm and 5mm.

CBR= (corrected load value/ standard load)*100.

Procedure for Penetration Test of Bitumen

The bitumen is softened to a pouring consistency, stirred well, and poured into the test containers. The depth of bitumen in the container is kept at least 15mm more than the expected penetration. (I.S. 1203-1958). Related:- California Bearing Ratio(CBR Test) of Subgrade Soil -Procedure, apparatus, and use for pavement Design

Now the sample containers are placed in a temperature-controlled water bath at a temperature of 25 c for one hour.Then at the end of one hour, the sample is taken out of water bath and the needle is brought in contact with the surface of bitumen sample at that time reading of dial is set at zero or the reading of dial noted, when the needle is in contact with the surface of the sample.

After that, the needle is released and the needle is allowed to penetrate for 5 seconds and the final reading is recorded. On that sample at least three penetration observations should be taken at distances at least 10 mm apart. After each test, the needle should be disengaged, wiped with benzene, and dried. The amount of penetration is recorded.

The main value of the three measurements is reported is the penetration test.

The accuracy of the test depends upon pouring temperature, size of the needle, the weight placed on the needle, and test temperature.

grade of bitumen is specified in terms of penetration value. For example, 30/40 grade bitumen indicates the penetration value of the bitumen in the range of 30 to 40 at standard test conditions.

SOFTENING POINT TEST ON BITUMEN

Softening point denotes the **temperature** at which the **bitumen** attains a particular degree of **softening** under the specifications of **test**. The **test** is conducted by using Ring and Ball apparatus. A brass

ring containing **test** sample of **bitumen** is suspended in liquid like water or glycerin at a given **temperature**.

The softening point of bitumen or tar is the temperature at which the substance attains particular degree of softening. As per IS: 334-1982, ASTM E28-67 or ASTM D36 or ASTM D6493 - 11, it is the temperature in ºC at which a standard ball passes through a sample of bitumen in a mould and falls through a height of 2.5 cm, when heated under water or glycerine at specified conditions of test. The binder should have sufficient fluidity before its applications in road uses.

A. Uses of Softening Point

The determination of softening point helps to know the temperature up to which a bituminous binder should be heated for various road use applications. Softening point is determined by ring and ball apparatus.

B. Apparatus for Softening Point Test

1. The ring and ball apparatus consisting of:

1. Steel balls-two numbers each of 9.5 mm diameter weighing 3.5 ± 0.05 g.
2. Brass rings-two numbers each having depth of 6.4 mm. The inside diameter at bottom and top is 15.9mm and 17.5 mm respectively.
3. Ball guides to guide the movement of steel balls centrally.
4. Support -that can hold rings in position and also allows for suspension of a thermometer. The distance between the bottom of the rings and the top surface of the bottom plate of the support is 25mm.

2. Thermometer that can read up to 100° C with an accuracy of 0.2° C. 3. Bath-heat resistant glass beaker not less than 85 mm in diameter &1220mm deep. 4. Stirrer

1. Preparation of test sample Heat the material to a temperature between 75-100° C above its softening point; stir until, it is completely fluid and free from air bubbles and water. If necessary, filter it through IS sieve 30. Place the rings previously heated to a temperature approximating to that of the molten material, on a metal plate which has been coated with a mixture of equal parts of glycerine and dextrin. After cooling for 30 minutes in air, level the material in the ring by removing the excess material with a warmed, sharp knife. 2. Assemble the apparatus with the rings; thermometer and ball guides in position 3. Fill the bath with distilled water to a height of 50mm above the upper surface of the rings. The starting temperature should be 5° C. **Note**: Use glycerin in place of water if the softening point is expected to be above 80° C; the starting temperature may be kept 35° C. 4. Apply heat to the bath and stir the liquid so that the temperature rises at a uniform rate of 5 ± 0.5 °C per minute. 5. As the temperature increases the bituminous material softens and the balls sink through the rings carrying a portion of the material with it. 6. Note the temperature when any of the steel balls with bituminous coating touches the bottom plate. 7. Record the temperature when the second ball touches the bottom plate. The average of the two readings to the nearest 0.5°C is reported as softening point.

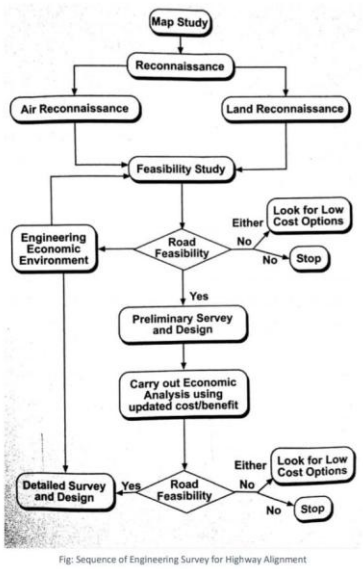

Fig: Sequence of Engineering Survey for Highway Alignment

CONCLUSION

Development of a country depends on the connectivity of various places with adequate road network. Roads are the major channel of transportation for carrying goods and passengers. They play a significant role in improving the socio-economic standards of a region. Roads constitute the most important mode of communication in areas where railways have not developed much and form the basic infra-structure for the development and economic growth of the country.

The benefits from the investment in road sector are indirect, long-term and not immediately visible. Roads are important assets for any nation. However, merely creating these assets is not enough, it has to be planned carefully and a pavement which is not designed properly deteriorates fast. Nepal is a small country having huge resource of materials.

If these local materials are used properly, the cost of construction can be reduced. There are various type of pavements which differ in their suitability in different environments. Each type of pavement has its own merits and demerits. Despite a large number of seminars and conference, still in India, 98% roads are having flexible pavements. A lot of research has been made on use of Waste materials but the role of these materials is still limited. So there is need to take a holistic approach and mark the areas where these are most suitable. India has one of the largest road networks in the world (over 3 million km at present). For the purpose of management and administration, roads.

Nepal's economical growth plan of over 6% per annum for the next 20 years will, to a great extent, depend on an efficient road infrastructure, not only national highways but other roads too, including link roads for rural connectivity, which can provide fast movement of goods and people with safety and economical cost to the user. government of India has drawn up Pradhan Mantri gram SarakYojana(PMGSY) for implementation of rural connectivity. it is estimated that in the next 7 years, road works under PMGSY worth Rs. 1200 crores are to be constructed. Since road pavements are an important part of these projects, costing about 50% of the investment, a careful evaluation of the alternatives is necessary to make the right choice on a rational basis, which may be comparatively more beneficial to the nation.

The collected Secondary data from the Metropolitan Office were collected after the sample selection process. The data obtained were analyzed as per the objective of the study on the basis of the parameters taken for evaluation. The documents which are available from the planning section of the Metropolitan Office are thoroughly studied. During the study, the collected information was not well documented as per requirement, such as design, drawing, and quality assurance documents.

Like other countries, construction projects in Nepal are also facing delay in completion.
Many infrastructure projects are not being completed within the stipulated time originally
provided in the contract. The ultimate effects of project delay also results in cost overrun.
Public tendering on construction is governed by "Public Procurement Act 2007 (PPA) and Public Procurement Regulation 2007" (PPR) in Nepal. There is provision of "duration to be mentioned while preparing the cost estimate" in rule 9 of the Regulation but this provision does not state the methods of determining the construction contract duration (CCD).

Department of Roads (DoR) is a one of the major Departments under the government of Nepal for infrastructure development. DoR has been managing comparatively large road and bridge construction projects through several local as well as international contracts each year. Only few projects have successfully completed within intended schedule while many projects are facing significant time over run. The duration of a construction project depends primarily on the quantity or magnitude of the construction work and the productivity of the construction crew. In addition, many other factors may also affect the construction duration, such as the type of construction, location and any special features of the project.

It is true that there is no scientific method and scheduling technique being applied in determining the real contract period necessary for the completion of the projects in various geographical locations and working conditions. The method being applied till date to determine contract duration for construction projects in Nepal is mostly ad-hoc irrespective of geographic complexity, nature of work and the workable
day considerations. Similarly the contract duration is inconsistent in different projects. departmental guideline seems necessary for determination of appropriate and consistent contract period with logical basis.

In this light, DoR had decided to form a committee in November 24, 2014 to prepare a guideline for the basis of determining contract duration in road and bridge

contracts under the DoR. The committee comprises of DDG Mr.Keshabkumar Sharma, as Coordinator; and RD Mr.MuktiGautam, SDE Mr.Rajendra Raj Sharma, SDE Mr.Gambhir Shrestha, SDE Mr.Prabhat Kumar Jha and Consultant Mr. Vishnu Prasad Shrestha as members. The committee has prepared this document after wide consultation with the concerned persons and study of the best practices currently adopted in various countries. This guideline will be helpful in determining construction contract duration for the road and bridge projects in DoR.

FUTURE SCOPE

'Disruption' is a common word when applied tobusiness: just consider how Amazon changed retailand how both Uber and Tesla have entered-andcould further disrupt-the car industry.

The same is happening in the roads sector, in terms of the data available to highway authorities to understand the condition of their networks.

Recent years have seen advances in video capturetechnology, big data and more accurate depreciationsoftware that have shown a potential to drivebenefits to local highway.

Machine learning applications are also supportingdecision making and showing impressive results.

Anartificial intelligence system developed by Google, for example, was found to be more accurate indetecting breast cancer than human radiologists.

Surely the time is right for the highways sector tostart taking advantage of such developments andapply them to the process for collecting andanalysing data from roads and associated.

REFERENCES

[1] Highway construction and maintenance by Avinashgupta
[2] Highway road replacement :processes, techniques and advancement.
[3] Low volume Road engineering by Robert A Douglas
[4] Manual of contract Document for highways and highway construction by Great britian
[5] Cold regions pavement engineering by Guy dore and hannelezubeck
[6] Highway engineering by Martin rogers
[7] Road engineering:Design, Rehabilition and maintenance of modern highway by jim
[8] Heavy highway construction by NCCER
[9] Material,construction,maintenance and Testing of pavement by Dar Hao Chen and cindyEstakhri
[10] Construction maintenance restoration and rehabilition of Highway by Rakshit K S