ESTIMATION OF QUANTITIES AND SCHEDULING OF PROJECT NATIONAL HIGHWAY NO-2 (Agra- Gwalior Bypass)

A Project Report

Submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN
CIVIL ENGINEERING

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to

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CERTIFICATE

This is to certify that the work which is being presented in the project title **"ESTIMATION OF QUANTITIES AND SCHEDULING OF PROJECT NATIONAL HIGHWAY NO-2 (Agra-Gwalior Bypass)"** in partial fulfillment of the requirements for the award of the degree of Bachelor of technology and submitted in Civil Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Indresh Mangal (121605) and Sudhanshu Singh (121712)** during a period from July 2015 to December 2015 under the supervision of **Mr. Abhilash Shukla** Assistant Professor, Civil Engineering Department, Jaypee University of Information Technology, Waknaghat.

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ABBREVIATIONS

Conc……………………………………………………………………..Concrete

Cum .. ……………………………………………………………Cubicmeter

DBM ………….……………………………….. Dense Bituminous Macadam

H.M.P …………………..…………..…………………………..Hot Mix Plant

HP………………………………………… ……………….. horse Power

hrs/Hrs……………………..……………………………………. hour/Hours

kg……………………………..……………………………….. Kilograms

km………………………………..…………………………… Kilometre

kWh…………………………………………………...……. Kilowatt—hour

Lit(s)……………………………………………………..………………. Litres

mm……………………………………………………………..……. Millimetre

MT……………………………………………………………… metric tonne

No…………………………………………………………………… Number

PCC ……………………… ……… ………………….. Plain Cement Concrete

P.C.C………………………………………………… Profile Corrective Course

POL…………………………………………………..….. Petrol, Oil and Lubricant

RCC……………………………………………. Reinforced Cement Concrete

Sq.m./sq.m ………………………..…………………….......... Square Meter

SSR……………………………………..………… Standard Schedule of Rate

TPH………………………………………………………… Tonnes per Hour

Ton/tonne……………………………………………………………..Tonne

WMM……………………………..……………………….Wet Mix Macadam

MoRT&H … ………………………..Ministry of Road Transport and Highways

IS……… … …… ………………… ……………………………..……Indian Standard

IRC……………………… ………………………………….Indian Road Congress

T&P…………………..……………………………………………Tools and Plants

GI……………………… ………………………………………..Galvanised Iron

CJ…………………… ………………..…………………………..Cast Iron

GL…………………………………..…………………………Ground level

Rs……………………………………………..……………………..Rupees

Min…………………………………………………...……………..Minimum

Max…………………………………………………………...……….Maximum

BM ……………………………………………………….Bituminous Macadam

SDBC…………………………………… ……..Semi-Dense Bituminous Concrete

BC…………………… ………………..…………………..Bituminous Concrete

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Chapter 1- INTRODUCTION

1.1 PROJECT SCHEDULING

In project management, a schedule is a listing of a project's milestones, activities, and deliverables, usually with intended start and finish dates. Those items are often estimated in terms of resource allocation, budget and duration, linked by dependencies and scheduled events. A schedule is commonly used in project planning and project portfolio management parts of project management. Elements on a schedule may be closely related to the work breakdown structure (WBS) terminal elements, the Statement of work, or a Contract Data Requirements List.

Before a project schedule can be created, the schedule maker should have a work breakdown structure (WBS), an effort estimate for each task, and a resource list with availability for each resource. If these components for the schedule are not available, they can be created with a consensus-driven estimation method like Wideband Delphi. The reason for this is that a schedule itself is an estimate: each date in the schedule is estimated, and if those dates do not have the buy-in of the people who are going to do the work, the schedule will be inaccurate.

- In order for a project schedule to be healthy, the following criteria must be met:

- The schedule must be constantly (weekly works best) updated.

- The EAC (Estimation at Completion) value must be equal to the baseline value.

- The remaining effort must be appropriately distributed among team members (taking vacations into consideration).

1.2 IMPORTANCE OF PROJECT SCHEDULING

Scheduling is the way we actually manage a project. Without scheduling, nothing or nobody is managing the project and hence amounts to failure of a project. Scheduling describes guidance and pathway for a project to run. It defines certain milestones and deliverables which need to be achieved on a timely basis for successful completion of a project. Monitoring the schedule provides an idea of the impact the current problems are having on the project, and provides opportunities to enhance or reduce the scope of a milestone/phase in the project.

It also provides a medium for continuous feedback on how the project is progressing and if there are issues that need to be dealt with or if the client needs to be told about a delay indelivery.

If you don't make a project schedule, it is very likely that you may have to spend sleepless nights rushing to finish the project on time. And at the end of the day, the quality of the finished project might bepoor.

Importance of a proper project scheduling is as follows:

- **Management needs project update status**

Anyone who has given you the task would like to know the status and progression. Without a proper project schedule it would be very difficult to tell your progression.

- **Splitting the work among co-workers**

With a project schedule and requirements document it would be easy to split work among co-workers. Each and every one working on the project would know their tasks.

- **Estimating starting and finishing dates**

Estimation of finishing date is vital to any project. If you have unlimited budget and time given for a project this will not be an issue. But unfortunately, in the real world everything is limited. So time estimation is essential.

1.3 HIGHWAY ALIGNMENT DESCRIPTION

The Ministry of Road Transport and Highways, Govt. of India, has authorised the National Highways Authority of India (NHAI) for Preparation of feasibility study and detailed project report for construction of new four lane Agra Bypass under Phase III of North-South and East-West corridors of National Highways in the state of Uttar Pradesh.

The proposed Agra Bypass is a new alignment proposed to connect NH-2 (Delhi-Agra Section) with NH-3 (Agra-Gwalior Section) on the Southern side of Agra. The alignment will meet NH-11 (Agra-Jaipur Section) and SH-39 (Agra-Jagener Section) in between. Besides, the alignment crosses two other roads namely Runkta-Kiraoli road and Agra-Achnera road.

The alignment starts at Km 176.800 on NH-2. An interchange has been proposed at this intersection along with a ROB over railway line. After taking off from NH-2 crosses the Delhi bound railway line, traverses agricultural fields and crosses minor canals like the Sikandra distributary, Agra canal, Agra distributary and moves southward till it reaches the railway line. There are a few small settlements along this alignment.

Thereafter, it crosses a road leading to Bharatpur and gradually deviating eastwards it reaches NH-3 crossing NH 11, Kota bound railway line, NH-11, SH-39 and Gwalior bound railway line on the way. This alternative passes through agricultural land and will entail totally new land acquisition for the entire stretch of nearly 32.80 km. The main features of this alignment can be summarised below:

- Total length of this alignment is about 32.80 km.
- All commercial and residential establishments have been bypassed
- There will be no seepage or submergence problems as there exists no water body
- This alignment runs mostly through agricultural land and the corridor is free of any major obstruction
- Sufficient land width can be made available for tree plantation
- There are 10 nos. of major structures which includes ROB’s, Flyovers and Khari River Bridge
- The alignment passes through the Basin of Khari River where it is proposed to provide on a major bridge 3x50m spans and a minor bridge.
- Junctions at crossing with other NH and state roads are proposed to be grade separated interchanges.

1.4 NHAI

The National Highways Authority of India (NHAI) is an autonomous agency of the Government of India, responsible for management of a network of over 70,000 km of National Highways in India. It is a nodal agency of the Ministry of Road Transport and +--Highways.

1.4.1 ESTABLISHMENT

The NHAI was created through the promulgation of the National Highways Authority of India Act, 1988. In February 1995, the Authority was formally made an autonomous body.

It is responsible for the development, maintenance, management and operation of National Highways, totaling over 92,851.05 km (57,694.97 mi) in length.

1.4.2 FUNCTIONS

The Authority is mandated to develop, maintain and manage the national highways and any other highways vested in, or entrusted to, it by the Government.

The Authority may, for the discharge of its functions:

-survey, develop, maintain and manage highways vested in, or entrusted to it.

-construct offices, or workshops and establish and maintain hotels, motels, restaurants and rest rooms at or near the highways vested in , or entrusted to, it.

-construct residential buildings and townships for its employees.

-regulate and control the plying of vehicles on the highways vested in, or entrusted to, it for the proper management thereof.

-develop and provide consultancy and construction services in India and abroad and carry on research activities in relation to the development, maintenance and management of highways or any facilities thereat.

-provide such facilities and amenities for the users of the highways vested in, or entrusted to, it as are, in the opinion of the Authority, necessary for the smooth flow of traffic on such highways.

Chapter-2 LITERATURE REVIEW

2.1 CRITICAL PATH METHOD[1]

Scheduling the construction process using critical path method (CPM) is essential so that projects can be completed profitably and on time. Because of its benefits and the significant advancements that have been made in both computer hardware and scheduling software, the use of the CPM and its precedence diagram method (PDM) variation in all industries, including construction, has dramatically increased in the last three decades.

While the CPM calculations are simple and straightforward, CPM-based scheduling is a challenging process. At the planning stage before construction, the CPM network may contain complex relationships that complicate the scheduling process. In addition, the CPM algorithm has no formulation to account for the multiple constraints in a project such as deadline and resource limit. While researchers have introduced remediation techniques such as time-cost trade-off analysis and resource levelling it is often difficult to produce a realistic schedule since a solution to one constraint (e.g., resource limits) may interfere with the solution to another (e.g., deadline). This difficulty adds to the perception that CPM and existing software are useful for organizational and reporting purposes but not for decision support to reflect and react to reality.

2.2 DESIGN BUILD PROJECTS[2]

Design–build (DB) is an integrated approach that delivers design and construction services under one contract with a single point of responsibility. It is increasingly popular not only in the United States but also in the international construction market due to its advantages, such as shorter project duration, early project cost certainty, and single-point responsibility for clients.

Due to the completion of an increasing number of DB projects in the United States, a number of empirical studies have been conducted into DB performance and in comparison with other delivery methods. In general, DB is found to be superior to the traditional delivery system in terms of time and cost performance. However, the sample sizes in these studies are generally quite small—the majority being less than 50 with the largest sample of 155. Additionally, some project performance evidence is opinion-based from questionnaire surveys of project participants rather than factual project information. Furthermore, rigorous studies have produced inconclusive support and only in terms of overall results, with few attempts being made to relate project characteristics with performance levels. An empirical study with a larger sample size to examine factual, finer performance data of DB projects is therefore necessary to obtain solid research findings.

2.3 REPETITIVE SCHEDULING METHOD[3]

Repetitive projects, which are commonly found in highways, railways, pipeline networks, and wind farms, are characterized by the repetition of activities in units. It has been argued that traditional network scheduling methods are not effective in modelling repetitive projects, and a series of suitable methods—including the repetitive scheduling method (RSM), linear scheduling methods, and the Kallantzis-Lambropoulos repetitive project model (KLRPM). RSM is used to describe a repetitive model in which a controlling path determines the makespan of a repetitive project. The network model has several specific disadvantages as compared to the RSM, namely,

(1) It is unable to provide resource continuity,

(2) It is difficult to update, and

(3) It cannot distinguish rates of progress among activities. In short, the RSM is more visual and straightforward and is easier to use in modelling repetitive projects.

In the field of project management, network models are widely accepted and used by both owners and construction contractors and are often required as part of the construction contract. If RSM can be transformed to an equivalent network, practitioners can take advantages of both methodologies.

A RSM usually contains two types of relations:

(1) Logical relations between units performing the same activity (i.e., the logical sequence from one unit to another given existing resource continuity constraints), and

(2) Precedence relations, which regulate the constraints—including the distance and time constraints—between different activities.

2.4 FLOAT CONSUMPTION IMPACT MODEL[4]

The main objectives of construction projects are completing the project on time and within budget. Typically, there is a trade-off between time and cost. As the project's duration is shortened, the direct cost increases while the indirect cost decreases. Contractors and clients strive to optimize the project duration and cost to maximize the return.

The main objective of time–cost trade-off is to determine the optimum project duration associated with the minimum total cost (direct and indirect costs). Typically, the project's total cost decreases through crashing critical activities until it reaches a certain project duration where the total cost starts to increase. This is called the optimum duration point, which is associated with the minimum total cost.

The critical-path method is the most commonly used method for scheduling construction projects. The critical paths consist of activities that have zero total float. Total float is defined as the amount of time that an activity can be delayed without delaying the whole project. Total float is shared among the activities on the same path. Free float, by contrast, is available to the particular activity. Free float is defined as "the amount of time by which the finish time of an activity may exceed its earliest finish time without increasing the earliest start time of any other activity immediately following." Compared with total float, the use of the free float is rather limited. Free float can be used for resource-levelling applications. The float on noncritical activities leads to efficient resource utilization. Total float represents the flexibility in the construction schedule. Total float is an important scheduling element that is used by contractors to change the start of noncritical activities for resource-management purposes and for time– cost optimization. The amount of float is essential for resource levelling and time–cost trade-off.

A nonlinear-integer programming (NLIP) model is developed to solve the optimization problem while taking into account the total float-loss cost.

2.5 FUZZY MATHEMATICAL MODELS[5]

Optimization models have been used in construction projects, but they have not been successful when used on large networks. CPM techniques with discrete information instead of continuous membership functions have proven to be more efficient and they provide not optimal, but usable solutions. However, some optimization techniques present the opportunity for analyzing more than one objective at a time and this permits a more realistic approach. Uncertainties have been analyzed by using fuzzy goal programming and optimal solutions have been achieved while simultaneously considering two objectives and using membership functions Furthermore, uncertainties have been considered in diverse project settings using the fuzzy set theory, which provides possible completion times for each activity in a network.

Fuzzy logic is a form of many-valued logic in which the truth values of variables may be any real number between 0 and 1. By contrast, in Boolean logic, the truth values of variables may only be 0 or 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false. Furthermore, when linguistic variables are used, these degrees may be managed by specific functions.

It has been used in recognition of hand written symbols in Sony pocket computers; flight aid for helicopters; controlling of subway systems in order to improve driving comfort, precision of halting, and power economy; improved fuel consumption for auto mobiles; single-button control for washing machines; automatic motor control for vacuum cleaners with recognition of surface condition and degree of soiling; and prediction systems for early recognition of earthquakes through the Institute of Seismology Bureau of Metrology, Japan.

2.6 BAYESIAN NETWORK[6]

Bayesian Networks (BNs) are recognised as a mature formalism for handling causality and uncertainty. This section provides a brief overview of BNs and describes a new approach for scheduling project activities in which CPM parameters (i.e. ES, EF, LS and LF) are determined in a BN.

Bayesian Networks (also known as Belief Networks, Causal Probabilistic Networks, Causal Nets, Graphical Probability Networks, Probabilistic Cause-Effect Models, and Probabilistic Influence Diagrams) provide decision-support for a wide range of problems involving uncertainty and probabilistic reasoning.

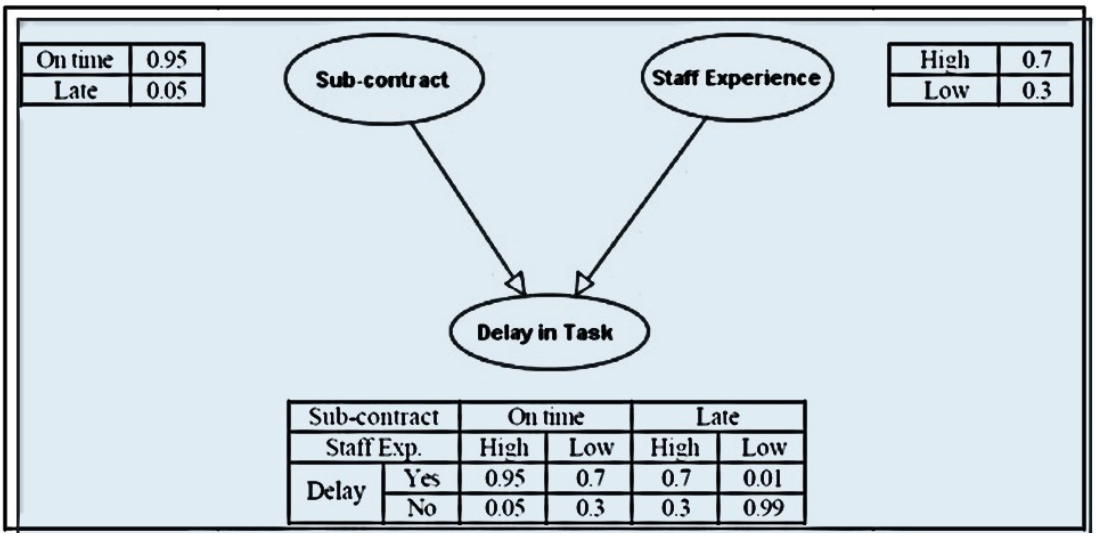


Figure 2.1 : A Bayesian Network Showing Nodes, Arcs and Probabilities

2.7 PRIMAVERA[7]

Oracle's Primavera P6 Professional Project Management gives today's project managers and schedulers the one thing they value most: control. Primavera P6 Professional Project Management, the recognized standard for high-performance project management software, is designed to handle large-scale, highly sophisticated and multifaceted projects. It can be used to organize projects up to 100,000 activities, and it provides unlimited resources and an unlimited number of target plans. Massive data requires sophisticated yet highly flexible organization tools to provide you a multitude of ways to organize, filter and sort activities, projects, and resources. In addition, Primavera P6 can be integrated with most financial and HR software via EcoSys EPC, an easy-to-use, web-based enterprise project controls software platform. It features best-in-class integration for bringing together schedule, cost, and other vital project data to form a "single version of the truth" for greater speed, accuracy, and efficiency in reporting.

Benefits:

-Balance resource capacity

-Plan, schedule, and control complex projects

-Allocate best resources and track progress

-Monitor and visualize project performance versus plan

-Conduct what-if analysis and analyze alternative project plan.

2.8 PRODCUTIVITY AND ITS IMPORTANCE IN SCHEDULING

Once the equipment needs for an activity have been identified, the next step is to conduct an equipment productivity analysis to select the optimum size. The objective is to determine the number of units and the size of equipment that would permit the constructor to accomplish the activity with a duration resulting in the lowest cost.

Because most civil engineering construction projects are awarded based on lowest cost, it is of utmost importance to the constructor to select the proper equipment spread providing the lowest construction cost for the project. The project is segmented into various activities; therefore, the lowest cost must be determined for each activity.

2.9 COMPOSITION AND STRUCTURE OF PAVEMENT

Flexible pavements support loads through bearing rather than flexural action. They comprise several layers of carefully selected materials designed to gradually distribute loads from the pavement surface to the layers underneath. The design ensures the load transmitted to each successive layer does not exceed the layer's load-bearing capacity. The various layers composing a flexible pavement and the functions they perform are described below:

2.9.1 Bituminous Surface (Wearing Course) The bituminous surface, or wearing course, is made up of a mixture of various selected aggregates bound together with asphalt cement or other bituminous binders. This surface prevents the penetration of surface water to the base course; provides a smooth, well-bonded surface free from loose particles, which might endanger aircraft or people; resists the stresses caused by aircraft loads; and supplies a skid-resistant surface without causing undue wear on tires.

2.9.2 Base Course The base course serves as the principal structural component of the flexible pavement. It distributes the imposed wheel load to the pavement foundation, the subbase, and/or the subgrade. The base course must have sufficient quality and thickness to prevent failure in the subgrade and/or subbase, withstand the stresses produced in the base itself, resist vertical pressures that tend to produce consolidation and result in distortion of the surface course, and resist volume changes caused by fluctuations in its moisture content. The materials composing the base course are select hard and durable aggregates, which generally fall into two main classes: stabilized and granular. The stabilized bases normally consist of crushed or uncrushed aggregate bound with a stabilizer, such as Portland cement or bitumen. The quality of the base course is a function of its composition, physical properties, and compaction of the material.

2.9.3 Subbase This layer is used in areas where frost action is severe or the subgrade soil is extremely weak. The subbase course functions like the base course. The material requirements for the subbase are not as strict as those for the base course since the subbase is subjected to lower load stresses. The subbase consists of stabilized or properly compacted granular material.

2.9.4 Frost Protection Layer Some flexible pavements require a frost protection layer. This layer functions the same way in either a flexible or a rigid pavement.

2.9.5 Subgrade The subgrade is the compacted soil layer that forms the foundation of the pavement system. Subgrade soils are subjected to lower stresses than the surface, base, and subbase courses. Since load stresses decrease with depth, the controlling subgrade stress usually lies at the top of the subgrade.

The combined thickness of subbase, base, and wearing surface must be great enough to reduce the stresses occurring in the subgrade to values that will not cause excessive distortion or displacement of the subgrade soil layer.

- Further, these pavements can have reinforcing steel, which is generally used to reduce or eliminate joints.
- Because of its relative rigidity, the pavement structure distributes loads over a wide area with only one, or at most two, structural layers.
- This type of pavement can serve 20 to 40 years with little or no maintenance or rehabilitation and often used in urban and high traffic areas.

2.10 MS PROJECT

Project creates budgets based on assignment work and resource rates. As resources are assigned to tasks and assignment work estimated, the program calculates the cost, equal to the work times the rate, which rolls up to the task level and then to any summary tasks and finally to the project level. Resource definitions (people, equipment and materials) can be shared between projects using a shared resource pool. Each resource can have its own calendar, which defines what days and shifts a resource is available. Resource rates are used to calculate resource assignment costs which are rolled up and summarized at the resource level. Each resource can be assigned to multiple tasks in multiple plans and each task can be assigned multiple resources, and the application schedules task work based on the resource availability as defined in the resource calendars. All resources can be defined in label without limit. Therefore, it cannot determine how many finished products can be produced with a given amount of raw materials. This makes Microsoft Project unsuitable for solving problems of available materials constrained production. Additional software is necessary to manage a complex facility that produces physical goods.

The application creates critical path schedules, and critical chain and event chain methodology third-party add-ons also are available. Schedules can be resource leveled, and chains are visualized in a Gantt chart. Additionally, Microsoft Project can recognize different classes of users. These different classes of users can have differing access levels to projects, views, and other data. Custom objects such as calendars, views, tables, filters, and fields are stored in an enterprise global which is shared by all users.

Chapter- 3 ABOUT THE PROJECT

3.1 OBJECTIVES OF THE PROJECT

The objective of the project is to do planning and scheduling of a Four Lane Highway (Agra bypass) using the optimum technique and completing the project in stipulated time with optimal use and scheduling of resources, levelling of resources and optimizing the cost of project and various activities.

Different objectives of the project during the stipulated period of 2 semester:

- Studying different techniques of scheduling and estimation
- Calculating the delays
- Comparing different techniques
- Preparing the schedule using Primavera and MS Project
- Estimating the BOQ

Objectives achieved till 7th semester are:

- Studying various techniques of scheduling and planning
- Comparing these techniques
- Activity defining
- Studying the basic cross section of the project and design using AutoCAD
- Quantity estimation in various kinds of alignment

Different objectives for the period of 8th semester were:

- Calculating the duration of activities based on the productivity rates of resources.
- Scheduling the alignments based on the duration calculated using primavera.
- Scheduling the alignments based on the duration calculated using MS Project.

3.2 PLAN OF THE PROJECT

The basic objective of this project is to do the scheduling of a four lane highway (Agra bypass) using the most optimum technique and making sure that the certain accuracy is acquired in the estimation of cost and time with the use of optimal resources.

As we have discussed earlier that the project itself is a huge project therefore to do the estimation of the whole project in entirety is a cumbersome job in itself. Hence we have resolved to do the estimation and scheduling for 1 km stretch taking into account the presence of ROB's ,Culverts and ensuring that the both horizontal and vertical curves that are present in the actual project are taken into account proportionately. Now once we have the estimation of 1 km stretch of the concerned highway, we will multiply by the result by the length of the highway i.e; 32.8km to get the approximate cost of the project. However, this technique is not precise but gives the approximate results which is what our intended objective is. This semester's work included calculation of the duration of these activities based on the production rates and then schedule the project using primavera and MS Project.

The plan of the project may be broken down into following steps:

- Firstly, the basic cross-section of the proposed alignment of the highway is studied and is also shown using AutoCAD.

- The activities involved in the construction process is studied sequentially and the requirements of resources for each is determined. The requirements are determined based on codal provisions and completed projects of the same nature.

- Once we know the resources and manpower required, estimation of quantities is done using MS EXCEL.

- Using the quantities calculated in the previous semester, duration of various activities are found out based on productivity.

- Then, using the duration of activities project is scheduled on Primavera and MS Project.

3.3 SIGNIFICANCE OF THE PROJECT

To organize and complete your projects in a timely, quality and financially responsible manner, you need to schedule projects carefully. Effective project scheduling plays a crucial role in ensuring project success. Important factors include financial, documentation, management and quality assurance.

3.3.1 Financial

Project scheduling impacts the overall finances of a project.This is particularly true when resources must have highly specialized skills and knowledge in order to complete a task or when costly materials are required. Completing a project in a short time frame typically costs more because additional resources or expedited materials are needed. With accurate project scheduling, realistic estimates and accurate projections prevent last-minute orders that drive up costs.

3.3.2 Documentation

Creating a comprehensive work breakdown structure allows you to create a chart, such as a Gantt chart, that lists the project tasks, shows dependencies and defines milestones. Management consultant Henry Gantt designed this type of chart to show a graphic schedule of planned work. Its role in business projects is to record and report progress toward project completion. Your project schedule also allows you to assign human resources to the work and evaluate their allocation to ensure you have the appropriate levels of utilization. You may also develop a program evaluation and review technique chart, or PERT chart, to help you analyze project tasks.

3.3.3 Management

Effective project managers conduct regular meetings to get status reports. They use project scheduling meetings to check in with their team members and prevent costly misunderstandings. These regular meetings ensure that work flows from one process to the next and that each team member knows that he needs to do to contribute the project’s overall success.

3.3.4 Quality

Project scheduling ensures one task gets completed in a quality manner before the next task in the process begins. By assuring that quality measures meet expectations at every step of the way, you ensure that managers and team members address problems as they arise and don't wait until the end. No major issues should appear upon completion because you’ve established quality controls from the very beginning of the scheduling process. Effective project managers understand that ensuring quality control involves managing risks and exploiting opportunities to speed up the schedule when possible to beat the competition and achieve or maintain a competitive edge with a more reliable product.

Chapter- 4 PREREQUISITE DATA

Productivity and quantities of equipment used for calculating duration of activities are listed in the table below.

Equipment	Quantity	Productivity	Activity Used For
Dozer	1	200 cum/hr	Spreading of soil for embankment, GSB, Subgrade
		150 cum/hr	Clearing of land and cutting of trees
Dozer	1	250 cum/hr	Clearing of land and cutting of trees
Motor Grader	1	200 cum/hr	Spreading of soil for embankment, GSB, Subgrade
		50 cum/hr	GSB grading
		50 cum/hr	WMM Grading
Hydraulic Excavator	1	60 cum/hr	Excavating Earth
Tipper	10	5.5 cum/hr	Transportation of soil and other materials
Vibratory Roller	3	100 cum/hr	Compacting Earth
		60 cum/hr	GSB
		60 cum/hr	WMM
Smooth Wheeled Roller	1	40 cum/hr	BM Compaction
Wet Mix Plant	1	30 cum/hr	Wet Mix Production
Hot mix Plant	1	35 cum/hr	DBM/BM Production
Bitumen Distributor	1	1750 sqm/hr	Applying Bitumen Coat
Paver Finisher	1	40 cum/hr	Paving DBM/BM
Paver Finisher	1	43 cum/hr	Paving of WMM
Hydraulic Chip Spreader	1	1500 cum/hr	Surface Dressing
Pneumatic Road Roller	1	30 cum/hr	Rolling of Asphalt Surface
Bitumen Boiler Oil Fried	1	1500 litre/hr	Bitumen Spraying

Table 4.1: Equipment and their productivity

Chapter- 5 RESULTS

5.1 QUANTITY OF DIFFERENT ITEMS

Quantities required in the various works such as earthworks, sub base courses, base courses and bituminous courses are shown in the table no 1.

Particular	Straight Alignment	Horizontal Curve	Valley Curve	Summit Curve	Railway Over Bridge
Earthworks(m^3)	69949	48404.8	18390.6	17385.6	395.25
Sub base and Base Courses (m^3)	13313	9212.25	2795.63	2995.31	9.90
Bituminous Courses (m^3)	5081.2	3516.16	1067.04	1143.26	-
PCC in Substructure (m^3)	-	-	-	-	612.54
RCC in Substructure (m^3)	-	-	-	-	19.17
PCC in Superstructure (m^3)	-	-	-	-	11.25
RCC in Superstructure (m^3)	-	-	-	-	159.98
Backfilling Volume (m^3)	-	-	-	-	143.55
Wearing Courses (m^3)	-	-	-	-	26.66

Table 5.1: Quantities of Different Items

5.2 DRAWINGS

The cross section of the highway no-2, layers in the construction of highway are drawn in AutoCAD according to the specifications and are shown in the illustrations.

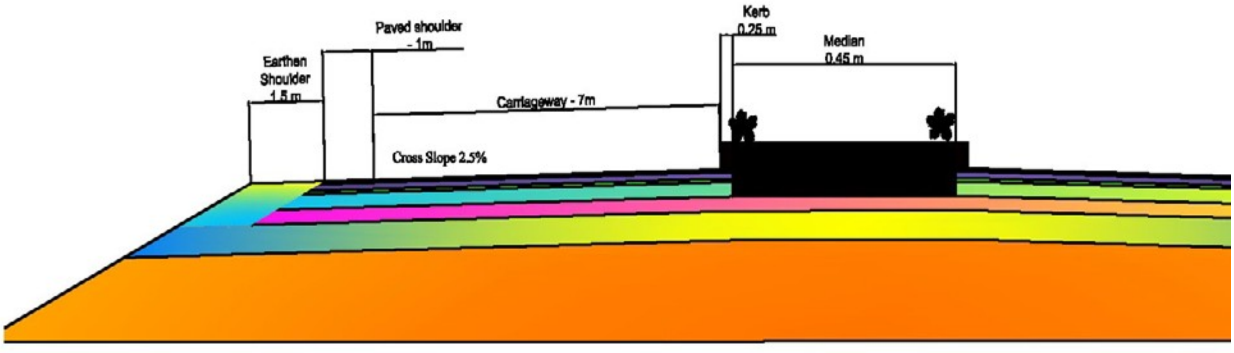


Figure 5.1: Cross section of the Highway

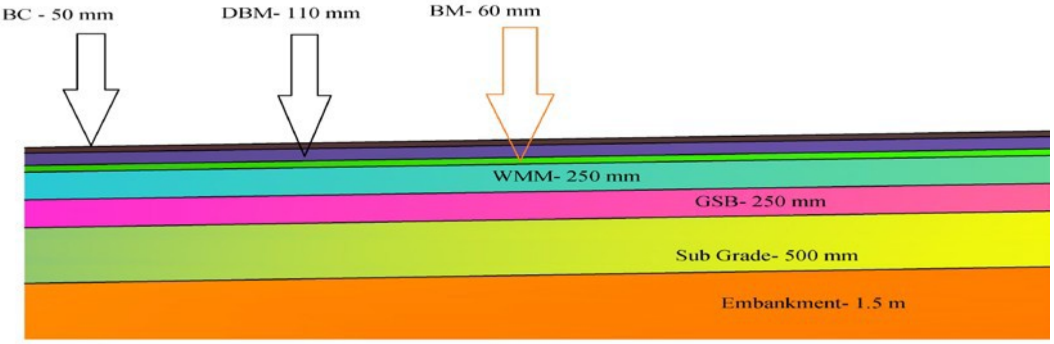


Figure 5.2 : Different Layers of Highway

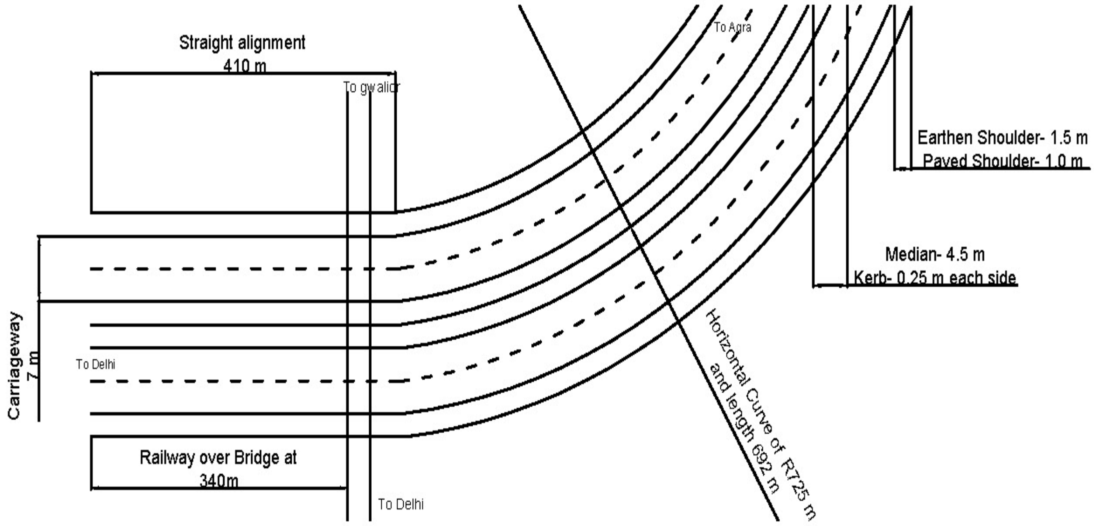


Figure 5.3 : Alignment of Highway

5.3 ACTIVITY DURATION

Duration of the activities found by using the productivities are as given in table 5.2

Duration are found out assuming an eight hour working day.

S.No.	Activities	Duration (In days)
1	Clearing of land	12
2	Excavation	
	For vertical Valley Curve	8
	For Horizontal Curve	11
3	Embankment Construction	
	Transportation of Soil	264
	Construction of Embankment for Straight Alignment	39
	Construction of Embankment for Vertical Valley Curve	9
	Construction of Embankment for Vertical Summit Curve	9
	Construction of Embankment for Horizontal Curve	31
4	Subgrade Construction	
	Transportation of Soil	71
	Construction of Subgrade for Straight Alignment	11
	Construction of Subgrade for Vertical Valley Curve	3
	Construction of Subgrade for Vertical Summit Curve	3
	Construction of Subgrade for Horizontal Curve	8
5	GSB Construction	
	Transportation From Quarry	33
	GSB Production	30
	Construction of GSB for Straight Alignment	9
	Construction of GSB for Vertical Valley Curve	2
	Construction of GSB for Vertical Summit Curve	2
	Construction of GSB for Horizontal Curve	6
6	Bitumen Coat on GSB	
	For Straight Alignment	2
	For Vertical Summit Curve	1
	For vertical Valley Curve	1

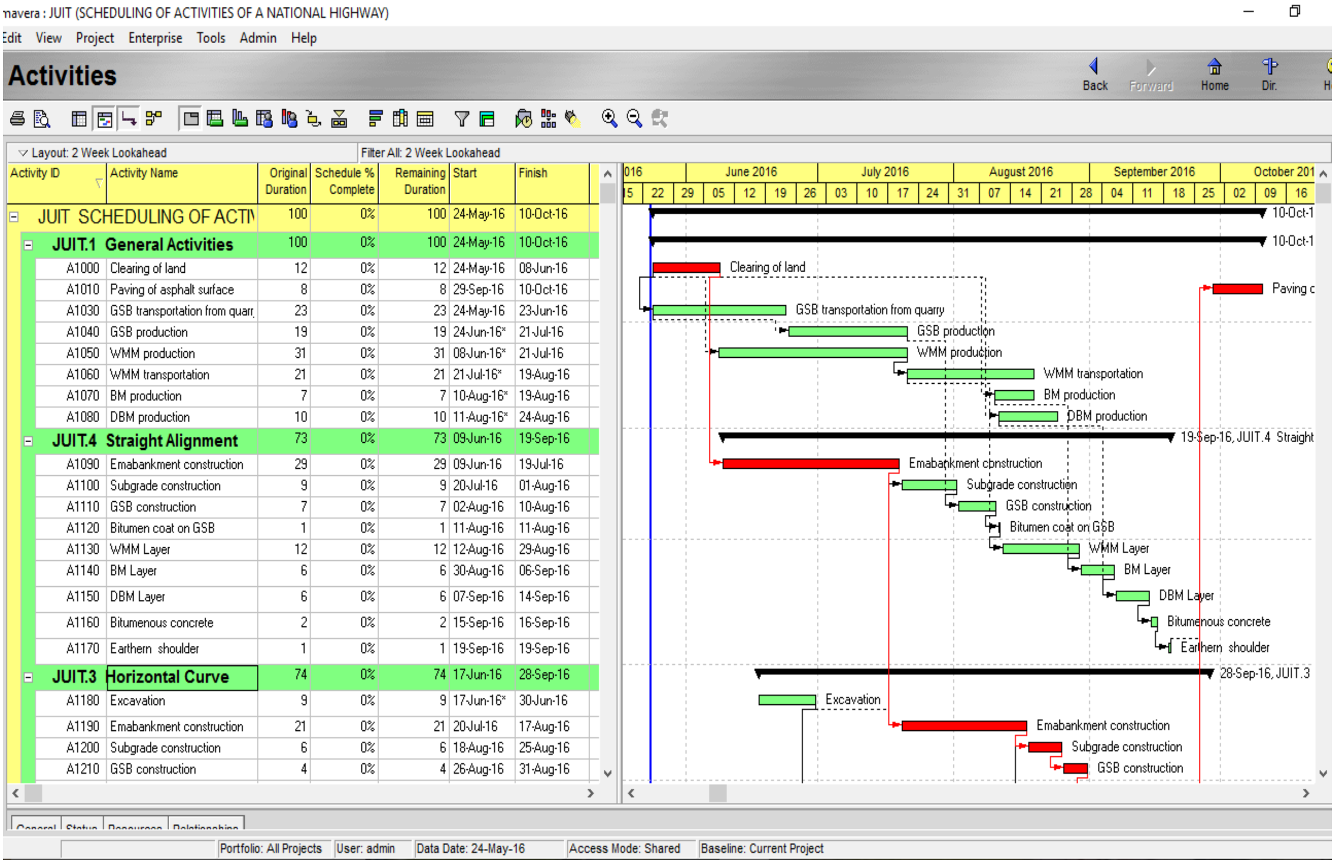
	For Horizontal Curve	1
7	WMM Layer	
	Production	59
	Transportation	32
	For Straight Alignment	18
	For Vertical Summit Curve	4
	For vertical Valley Curve	4
	For Horizontal Curve	12
8	BM Layer	
	Production	8
	For Straight Alignment	9
	For Vertical Summit Curve	2
	For vertical Valley Curve	2
	For Horizontal Curve	5
9	DBM Layer	
	Production	14
	For Straight Alignment	8
	For Vertical Summit Curve	2
	For vertical Valley Curve	2
	For Horizontal Curve	5
10	Bituminous Concrete	
	For Straight Alignment	3
	For Vertical Summit Curve	1
	For vertical Valley Curve	1
	For Horizontal Curve	2
11	Earthern Shoulder	
	Transportation of Soil	9
	For Straight Alignment	2
	For Vertical Summit Curve	1
	For vertical Valley Curve	1
	For Horizontal Curve	2
12	Paving of the Asphalt Surface	8

Table 5.2: Activities and their Durations

5.4 PRIMAVERA AND MS PROJECT RESULTS

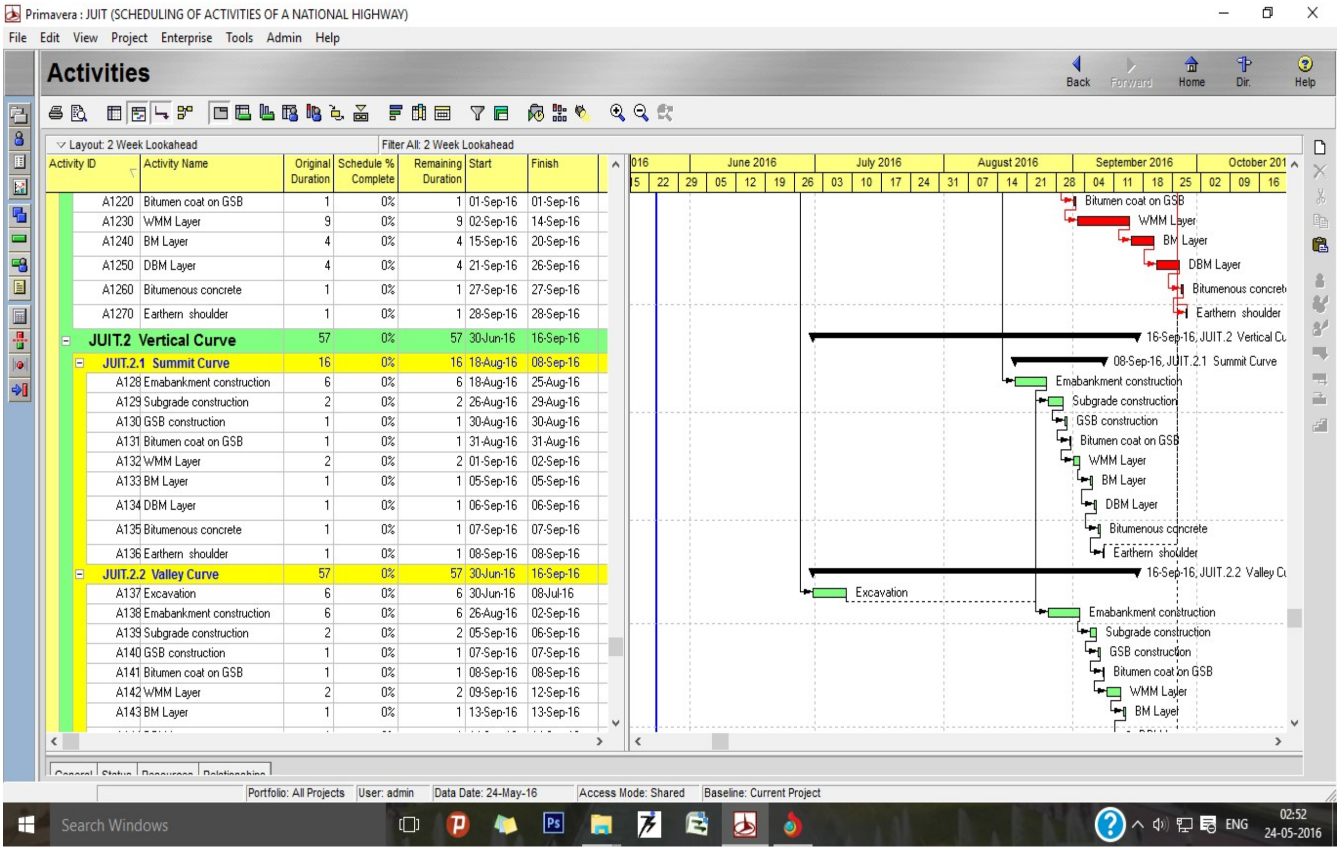
5.4.1 Schedule of activities in Primavera

Total duration of the project is calculated by using primavera and it comes out as 100 days for the complete stretch.



Activity ID	Activity Name	Original Duration	Schedule % Complete	Remaining Duration	Start	Finish
JUIT	SCHEDULING OF ACTIV	100	0%	100	24-May-16	10-Oct-16
JUIT.1	General Activities	100	0%	100	24-May-16	10-Oct-16
A1000	Clearing of land	12	0%	12	24-May-16	08-Jun-16
A1010	Paving of asphalt surface	8	0%	8	29-Sep-16	10-Oct-16
A1030	GSB transportation from quarr	23	0%	23	24-May-16	23-Jun-16
A1040	GSB production	19	0%	19	24-Jun-16*	21-Jul-16
A1050	WMM production	31	0%	31	08-Jun-16*	21-Jul-16
A1060	WMM transportation	21	0%	21	21-Jul-16*	19-Aug-16
A1070	BM production	7	0%	7	10-Aug-16*	19-Aug-16
A1080	DBM production	10	0%	10	11-Aug-16*	24-Aug-16
JUIT.4	Straight Alignment	73	0%	73	09-Jun-16	19-Sep-16
A1090	Emabankment construction	29	0%	29	09-Jun-16	19-Jul-16
A1100	Subgrade construction	9	0%	9	20-Jul-16	01-Aug-16
A1110	GSB construction	7	0%	7	02-Aug-16	10-Aug-16
A1120	Bitumen coat on GSB	1	0%	1	11-Aug-16	11-Aug-16
A1130	WMM Layer	12	0%	12	12-Aug-16	29-Aug-16
A1140	BM Layer	6	0%	6	30-Aug-16	06-Sep-16
A1150	DBM Layer	6	0%	6	07-Sep-16	14-Sep-16
A1160	Bitumenous concrete	2	0%	2	15-Sep-16	16-Sep-16
A1170	Earthern shoulder	1	0%	1	19-Sep-16	19-Sep-16
JUIT.3	Horizontal Curve	74	0%	74	17-Jun-16	28-Sep-16
A1180	Excavation	9	0%	9	17-Jun-16*	30-Jun-16
A1190	Emabankment construction	21	0%	21	20-Jul-16	17-Aug-16
A1200	Subgrade construction	6	0%	6	18-Aug-16	25-Aug-16
A1210	GSB construction	4	0%	4	26-Aug-16	31-Aug-16

Figure 5.4 : Primavera Result (Part 1)

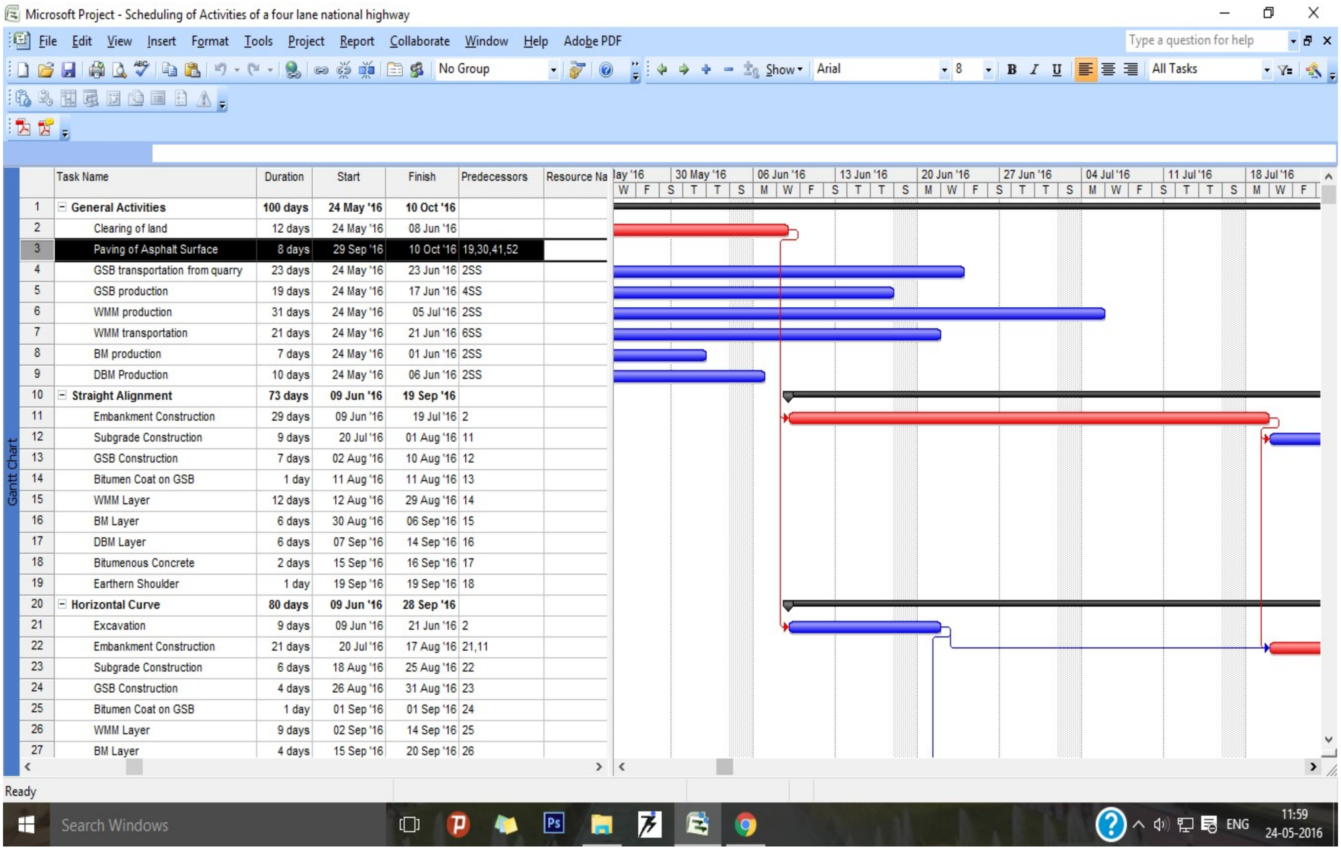


Activity ID	Activity Name	Original Duration	Schedule % Complete	Remaining Duration	Start	Finish
A1220	Bitumen coat on GSB	1	0%	1	01-Sep-16	01-Sep-16
A1230	WMM Layer	9	0%	9	02-Sep-16	14-Sep-16
A1240	BM Layer	4	0%	4	15-Sep-16	20-Sep-16
A1250	DBM Layer	4	0%	4	21-Sep-16	26-Sep-16
A1260	Bitumenous concrete	1	0%	1	27-Sep-16	27-Sep-16
A1270	Earthern shoulder	1	0%	1	28-Sep-16	28-Sep-16
JUIT.2	Vertical Curve	57	0%	57	30-Jun-16	16-Sep-16
JUIT.2.1	Summit Curve	16	0%	16	18-Aug-16	08-Sep-16
A128	Emabankment construction	6	0%	6	18-Aug-16	25-Aug-16
A129	Subgrade construction	2	0%	2	26-Aug-16	29-Aug-16
A130	GSB construction	1	0%	1	30-Aug-16	30-Aug-16
A131	Bitumen coat on GSB	1	0%	1	31-Aug-16	31-Aug-16
A132	WMM Layer	2	0%	2	01-Sep-16	02-Sep-16
A133	BM Layer	1	0%	1	05-Sep-16	05-Sep-16
A134	DBM Layer	1	0%	1	06-Sep-16	06-Sep-16
A135	Bitumenous concrete	1	0%	1	07-Sep-16	07-Sep-16
A136	Earthern shoulder	1	0%	1	08-Sep-16	08-Sep-16
JUIT.2.2	Valley Curve	57	0%	57	30-Jun-16	16-Sep-16
A137	Excavation	6	0%	6	30-Jun-16	08-Jul-16
A138	Emabankment construction	6	0%	6	26-Aug-16	02-Sep-16
A139	Subgrade construction	2	0%	2	05-Sep-16	06-Sep-16
A140	GSB construction	1	0%	1	07-Sep-16	07-Sep-16
A141	Bitumen coat on GSB	1	0%	1	08-Sep-16	08-Sep-16
A142	WMM Layer	2	0%	2	09-Sep-16	12-Sep-16
A143	BM Layer	1	0%	1	13-Sep-16	13-Sep-16

Figure 5.5: Primavera Result (Part 2)

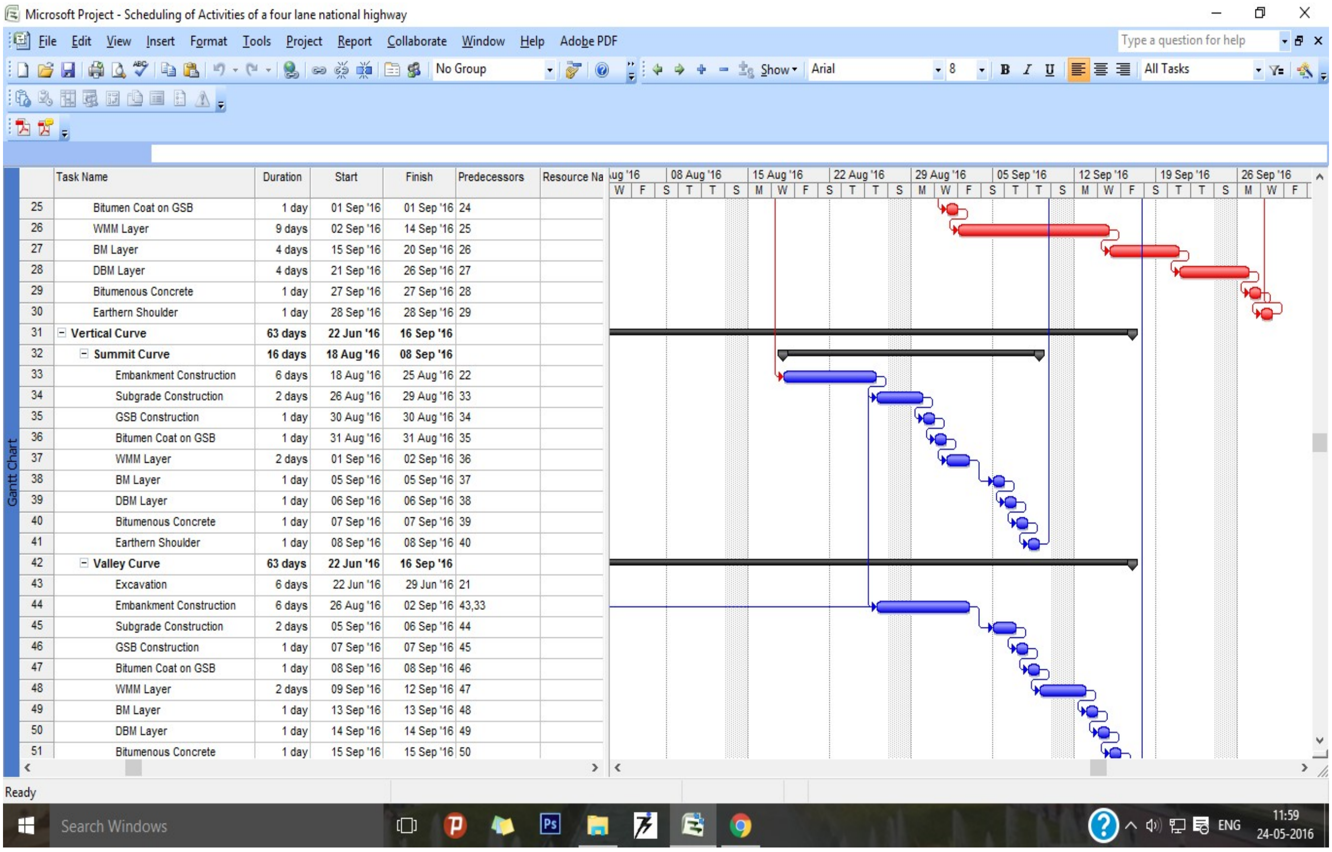
5.4.2 Schedule of activities in MS Project

Total duration of the project is calculated by using MS Project and it comes out as 100 days for the complete stretch.



	Task Name	Duration	Start	Finish	Predecessors	Resource Na
1	General Activities	100 days	24 May '16	10 Oct '16		
2	Clearing of land	12 days	24 May '16	08 Jun '16		
3	Paving of Asphalt Surface	8 days	29 Sep '16	10 Oct '16	19,30,41,52	
4	GSB transportation from quarry	23 days	24 May '16	23 Jun '16	2SS	
5	GSB production	19 days	24 May '16	17 Jun '16	4SS	
6	WMM production	31 days	24 May '16	05 Jul '16	2SS	
7	WMM transportation	21 days	24 May '16	21 Jun '16	6SS	
8	BM production	7 days	24 May '16	01 Jun '16	2SS	
9	DBM Production	10 days	24 May '16	06 Jun '16	2SS	
10	Straight Alignment	73 days	09 Jun '16	19 Sep '16		
11	Embankment Construction	29 days	09 Jun '16	19 Jul '16	2	
12	Subgrade Construction	9 days	20 Jul '16	01 Aug '16	11	
13	GSB Construction	7 days	02 Aug '16	10 Aug '16	12	
14	Bitumen Coat on GSB	1 day	11 Aug '16	11 Aug '16	13	
15	WMM Layer	12 days	12 Aug '16	29 Aug '16	14	
16	BM Layer	6 days	30 Aug '16	06 Sep '16	15	
17	DBM Layer	6 days	07 Sep '16	14 Sep '16	16	
18	Bitumenous Concrete	2 days	15 Sep '16	16 Sep '16	17	
19	Earthern Shoulder	1 day	19 Sep '16	19 Sep '16	18	
20	Horizontal Curve	80 days	09 Jun '16	28 Sep '16		
21	Excavation	9 days	09 Jun '16	21 Jun '16	2	
22	Embankment Construction	21 days	20 Jul '16	17 Aug '16	21,11	
23	Subgrade Construction	6 days	18 Aug '16	25 Aug '16	22	
24	GSB Construction	4 days	26 Aug '16	31 Aug '16	23	
25	Bitumen Coat on GSB	1 day	01 Sep '16	01 Sep '16	24	
26	WMM Layer	9 days	02 Sep '16	14 Sep '16	25	
27	BM Layer	4 days	15 Sep '16	20 Sep '16	26	

Figure 5.6: MS Project Result (Part 1)



	Task Name	Duration	Start	Finish	Predecessors	Resource Na
25	Bitumen Coat on GSB	1 day	01 Sep '16	01 Sep '16	24	
26	WMM Layer	9 days	02 Sep '16	14 Sep '16	25	
27	BM Layer	4 days	15 Sep '16	20 Sep '16	26	
28	DBM Layer	4 days	21 Sep '16	26 Sep '16	27	
29	Bitumenous Concrete	1 day	27 Sep '16	27 Sep '16	28	
30	Earthern Shoulder	1 day	28 Sep '16	28 Sep '16	29	
31	**Vertical Curve**	**63 days**	**22 Jun '16**	**16 Sep '16**		
32	**Summit Curve**	**16 days**	**18 Aug '16**	**08 Sep '16**		
33	Embankment Construction	6 days	18 Aug '16	25 Aug '16	22	
34	Subgrade Construction	2 days	26 Aug '16	29 Aug '16	33	
35	GSB Construction	1 day	30 Aug '16	30 Aug '16	34	
36	Bitumen Coat on GSB	1 day	31 Aug '16	31 Aug '16	35	
37	WMM Layer	2 days	01 Sep '16	02 Sep '16	36	
38	BM Layer	1 day	05 Sep '16	05 Sep '16	37	
39	DBM Layer	1 day	06 Sep '16	06 Sep '16	38	
40	Bitumenous Concrete	1 day	07 Sep '16	07 Sep '16	39	
41	Earthern Shoulder	1 day	08 Sep '16	08 Sep '16	40	
42	**Valley Curve**	**63 days**	**22 Jun '16**	**16 Sep '16**		
43	Excavation	6 days	22 Jun '16	29 Jun '16	21	
44	Embankment Construction	6 days	26 Aug '16	02 Sep '16	43,33	
45	Subgrade Construction	2 days	05 Sep '16	06 Sep '16	44	
46	GSB Construction	1 day	07 Sep '16	07 Sep '16	45	
47	Bitumen Coat on GSB	1 day	08 Sep '16	08 Sep '16	46	
48	WMM Layer	2 days	09 Sep '16	12 Sep '16	47	
49	BM Layer	1 day	13 Sep '16	13 Sep '16	48	
50	DBM Layer	1 day	14 Sep '16	14 Sep '16	49	
51	Bitumenous Concrete	1 day	15 Sep '16	15 Sep '16	50	

Figure 5.7: MS Project (Part 2)

Chapter- 5 CONCLUSION AND DISCUSSIONS

5.1 DISCUSSIONS

The project focuses on estimation of quantities of different items and scheduling of the activities related to the highway construction. During the course of the project quantities have been estimated for per km basis and shown in the aforementioned results. To calculate the quantities for the complete stretch of the road, simple multiplication of these quantities with the stretch will give us the approximate quantities for the major work involved. As the method used in estimating these quantities is trapezoidal method, the results obtained are approximate not accurate. So, same can be said about the total quantity which will be calculated after multiplication. This project helped us to get knowledge about the estimation works required in the construction of the highway.

The project focuses on estimation of quantities of different items and scheduling of the activities related to the highway construction. During the course of the project quantities have been estimated for per km basis and shown in the before mentioned results. This time duration of the activities are found out. Duration of an activity depends upon the resource amount and type allocated to it and in turn to the output or production rates of the resource. Production rates or productivity are dependent on various factors and are bound to change if there is change in weather conditions and management conditions and any other changes during the course of the project which needs to be taken into account to find the duration an activity will take.

After we had calculated the activity duration we proceeded with our major objective of scheduling the project using available mathematical models.

5.2 CONCLUSION

In this semester of the work, we have calculated and estimated the quantities required in various works during the construction of highway. Various quantities as estimated are 69949 cum, 13313cum, 5081.2 cum for earthworks, sub base and base courses and bituminous courses for 1km stretch of straight alignment respectively.

Similarly, quantities as estimated are 48404 cum, 9212.25cum, 3516.16 cum for earthworks, sub base and base courses and bituminous courses for 692 m stretch of horizontal curve respectively. This curve had a radius of 725 m and a maximum super-elevation of 5% and this super-elevation is achieved by the rotating the pavement about the centre of the median, which creates an equal cut and fill volume for the embankment.

Quantities as estimated for valley curve of stretch 210 m with a gradient of -2.8444, summit curve of stretch 225 m with a gradient of 2.000 and a railway over bridge of span 6 m are shown in the table 1 of the chapter results.

In 8th semester of the work, we have estimated and calculated the duration of the various activities involved in the highway construction. This was done using the productivities of various equipment and resources used in the highway construction. Calculated durations for the activities are shown in Chapter-5 of the project report. And productivities of the resources used are given in Chapter-4 of the project report.

Duration of the activities are found out according to the quantities estimated in the work of previous semester.

Total duration of the project as calculated by the MS Project and Primavera is 100 days.

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ANNEXURE-A

Quantity Estimation per km – Straight Alignment

S No.	Particulars of Items of Work	Unit	Length	Side Slope	Form-ation width	Depth	Qty
			Metre	V:H	metre	metre	
1	Clearance of land	sq metre	1000	-	35	-	35000
						Total	**35000**
2	**Earthworks**						
2.1	Excavation for roadwork in soil using hydraulic excavator including cutting and loading and trimming of side slopes	cum	1000	1	35	0	0
2.2	Construction of embankment with approved material with proper slope and properly compacted	cum	1000	0.5	35	1.5	53625
2.3	construction of subgrade with approved material and proper slope and compacted to meet the requirement	cum	1000	0.5	29	0.5	14625
2.4	construction of earthen shoulder with approved material and proper slope and compacted to meet the requirement	cum	1000	0.5	2	0.72	1699.2
						Total	**69949**
3	**SUB BASE AND BASE COURSES**						
3.1	Construction of Granular sub base by providing coarse graded material properly spread and compacted and mixed at OMC.	cum	1000	0.5	27	0.25	6781.3
3.2	Providing , laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing at OMC.	cum	1000	0.5	26	0.25	6531.3
						Total	**13313**
4	**Bituminous Courses**						
4.1	Providing and applying primer coat with bitumen emulsion on prepared surface of granular base	sqm	1000	0.5	26	0.05	1301.3
4.3	Providing and laying dense graded bituminous macadam for pavement	cum	1000	0.5	17.1	0.11	1887.1

4.4	Providing and laying Bituminous Macadam for pavement.	cum	1000	0.5	17.33	0.06	1041.6
4.5	Providing and laying Bituminous Concrete(BC)	cum	1000	0.5	17	0.05	851.25
						Total	**5081.2**

ANNEXURE – B

Constuction of 6m Span Minor bridge								
Sl. No	Description of item	Nos			L	B	D	Qty in cum
1	Earthwork in excavation for structures as per drawing and technical specifications construction of shoring and bracing, removal of stumps and other deleterious material and disposal upto a lead of 50 m, dressing of sides and bottom and backfilling in trenches with excavated suitablematerial.							
	For Footings abutments	1	X	2	2.70	8.70	1.65	77.52
	For piers	1	X	5	3.30	9.60	1.65	261.36
	for Wing walls	2	X	2	5.00	2.35	1.20	56.40
								395.28
								Cum
2	Providing concrete for plain concrete M 10 grade in open foundations using 40 mm nominal size Graded hard stone aggregate, mechanically mixed, placed in foundation and compacted by vibration including curing for 14 days complete as per drawings.							
	For Footings abutments	1	X	2	2.70	8.70	0.30	14.09
	for wing walls	2	X	2	5.00	2.35	0.30	14.10
	For piers	1	X	5	3.30	9.60	0.30	47.52
								75.71
								Cum
3	Plain cement concrete M 15 grade using 40,20 & 10mm metal mechanically mixed insubstructure.							
	Abutments 1st step	1	x	2	2.50	8.70	0.45	19.58
	for piers 1st step	1	x	5	3.00	9.60	0.45	64.80
	for wing walls	2	x	2	5.00	2.35	0.45	21.15
	2nd step abumtments	1	x	2	2.30	8.30	0.45	17.18
	Piers	1	x	5	2.70	9.20	0.45	55.89
	wing walls	2	x	2	5.00	1.95	0.45	17.55
	3rd step abumtments	1	x	2	2.10	7.90	0.45	14.93
	Piers	1	x	5	2.40	8.80	0.45	47.52

	wing walls	2	x	2	5.00	1.55	0.45	13.95
	Above GL abutments	1	x	2	7.50	$\frac{1.8+0.9}{2}$	2.10	42.53
	Above GL piers	1	x	5	8.40	$\frac{2.4+1.2}{2}$	2.10	158.76
	for wing walls	2	x	2	5.00	$\frac{1.4+0.7}{2}$	3.00	63.00
								536.83
								Cum
4	Providing concrete for reinforced concrete M 20 grade (Design Mix) in open foundations using 20 & 10 mm nominal size Graded hard stone aggregate, mechanically mixed, placed in foundation and compacted by vibration including curing for 14 days.							
	Bed blocks over abutments	1	x	2	7.50	0.90	0.30	4.05
	for piers	1	x	5	8.40	1.20	0.30	15.12
								19.17
5	Providing and laying reinforced cement concrete M25 grade (Design Mix) using 20 & 10mm metal mechanically mixed in superstructure.							
	For Deckslab 1st and last	1	x	2	7.50	7.90	0.45	53.33
	Centre slabs	1	x	4	7.50	7.90	0.45	106.65
								159.98
6	Providing and laying cement concrete wearing course M 30 (Design Mix) grade using 20 & 10mm metal mechanically mixed excluding reinforcement complete.							
	on slab	1	x	2	7.50	7.90	0.075	8.89
	Approaches	1	x	4	7.50	7.90	0.075	17.78
								26.66
7	Backfilling behind abutment, wing wall and return wall complete as per drawings & technical specification Clause 1204.3.8 MORD / 710.14 of IRC, 78 & 2200 MORTH including overhead charges & Contractors profit but excluding VAT.							
		1	X	2	5.00	6.60	$\frac{3.75+0.6}{2}$	143.55
								143.55
8	Construction of embankment with approved material obtained from borrow pits with all lifts.							
	Forming approach for diversion	1	x	1	120.00	6.00	0.500	360.00
								360.00
								Cum

9	Construction of granular sub-base by providing well graded material, spreading in uniform layers.							
	For approaches	1	x	2	5.00	6.60	0.150	9.90
								9.90
								Cum
10	Plain cement concrete M 15 grade using 40,20 & 10mm metal mechanically mixed in substructure complete as perdrawings							
	For approaches	1	x	2	5.00	7.50	0.150	11.25
								11.25
								Cum

ANNEXURE – C

	Quantity Estimation per km- Horizontal Curve Of Radius 725 m						
S No.	**Particulars of Items of Work**	**Unit**	**Length**	**Side Slope**	**Form-ation width**	**Depth**	**Qty**
			Metre	V:H	metre	metre	
1	Clearance of land	sq metre	692	-	35	-	35000
						Total	**35000**
2	**Earthworks**						
2.1	Excavation for roadwork in soil using hydraulic excavator including cutting and loading and trimming of side slopes	cum	692	1	35	0	0
2.2	Cutting of the ground for superelevation design when pavement is roatated about centre.	cum	692	-	17.5	0.87	-5267.85
2.3	Construction of embankment with approved material with proper slope and properly compacted	cum	692	0.5	35	1.5	37108.5
2.4	Extra Filling of embankment for superelevation design when pavement is roatated about centre.	cum	692	-	17.5	0.87	5267.85
2.5	construction of subgrade with approved material and proper slope and compacted to meet the requirement	cum	692	0.5	29	0.5	10120.5
2.6	construction of earthen shoulder with approved material and proper slope and compacted to meet the requirement	cum	692	0.5	2	0.72	1175.85
						Total	**48404.8**
3	**SUB BASE AND BASE COURSES**						
3.1	Construction of Granular sub base by providing coarse graded material properly spread and compacted and mixed at OMC.	cum	692	0.5	27	0.25	4692.63

3.2	Providing , laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing at OMC.	cum	692	0.5	26	0.25	4519.63
						total	**9212.25**
4	**Bituminous Courses**						
4.1	Providing and applying primer coat with bitumen emulsion on prepared surface of granular base	sqm	692	0.5	26	0.05	900.465
4.2	Providing and laying dense graded bituminous macadam for pavement	cum	692	0.5	17.1	0.11	1305.84
4.3	Providing and laying Bituminous Macadam for pavement.	cum	692	0.5	17.33	0.06	720.787
4.4	providing and laying Bituminous Concrete(BC)	cum	692	0.5	17	0.05	589.065
						Total	**3516.16**

ANNEXURE-D

Qty Estimation per km- Vertical Valley Curve Of Length 210m With gradient 2.8444							
S No.	**Particulars of Items of Work**	**Unit**	**Length**	**Side Slope**	**Form-ation width**	**Depth**	**Qty**
			Metre	V:H	metre	metre	
1	Clearance of land	sq metre	210	-	35	-	35000
						Total	**35000**
2	**Earthworks**						
2.1	Excavation for roadwork in soil using hydraulic excavator including cutting and loading and trimming of side slopes	cum	210	0.5	35	0.5	3701.25
2.3	Construction of embankment with approved material with proper slope and properly compacted	cum	210	0.5	35	2.25	11261.3
2.5	construction of subgrade with approved material and proper slope and compacted to meet the requirement	cum	210	0.5	29	0.5	3071.25
2.6	construction of earthen shoulder with approved material and proper slope and compacted to meet the requirement	cum	210	0.5	2	0.72	356.832
						Total	**18390.6**
3	**SUB BASE AND BASE COURSES**						
3.1	Construction of Granular sub base by providing coarse graded material properly spread and compacted and mixed at OMC.	cum	210	0.5	27	0.25	1424.06
3.2	Providing , laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing at OMC.	cum	210	0.5	26	0.25	1371.56
						total	**2795.63**
4	**Bituminous Courses**						
4.1	Providing and applying primer coat with bitumen emulsion on prepared surface of granular base	sqm	210	0.5	26	0.05	273.263

4.2	Providing and laying dense graded bituminous macadam for pavement	cum	210	0.5	17.1	0.11	396.281
4.3	Providing and laying Bituminous Macadam for pavement.	cum	210	0.5	17.33	0.06	218.736
4.4	providing and laying Bituminous Concrete(BC)	cum	210	0.5	17	0.05	178.763
						Total	**1067.04**

ANNEXURE – E

Qty Estimation per km- Vertical Summit Curve Of Length 225m With gradient 2.300							
S No.	**Particulars of Items of Work**	**Unit**	**Length**	**Side Slope**	**Form-ation width**	**Depth**	**Qty**
			Metre	V:H	metre	metre	
1	Clearance of land	sq metre	225	-	35	-	35000
						Total	**35000**
2	**Earthworks**						
2.1	Excavation for roadwork in soil using hydraulic excavator including cutting and loading and trimming of side slopes	cum	225	1	35	0	0
2.3	Construction of embankment with approved material with proper slope and properly compacted	cum	225	0.5	35	1.7	13712.6
2.5	construction of subgrade with approved material and proper slope and compacted to meet the requirement	cum	225	0.5	29	0.5	3290.63
2.6	construction of earthen shoulder with approved material and proper slope and compacted to meet the requirement	cum	225	0.5	2	0.72	382.32
						Total	**17385.6**
3	**SUB BASE AND BASE COURSES**						
3.1	Construction of Granular sub base by providing coarse graded material properly spread and compacted and mixed at OMC.	cum	225	0.5	27	0.25	1525.78
3.2	Providing , laying, spreading and compacting graded stone aggregate to wet mix macadam specification including premixing at OMC.	cum	225	0.5	26	0.25	1469.53
						total	**2995.31**
4	**Bituminous Courses**						
4.1	Providing and applying primer coat with bitumen emulsion on prepared surface of granular base	sqm	225	0.5	26	0.05	292.781

4.2	Providing and laying dense graded bituminous macadam for pavement	cum	225	0.5	17.1	0.11	424.586
4.3	Providing and laying Bituminous Macadam for pavement.	cum	225	0.5	17.33	0.06	234.36
4.4	providing and laying Bituminous Concrete(BC)	cum	225	0.5	17	0.05	191.531
						Total	**1143.26**

ANNEXURE F - Duration of Activities Based on Productivity

S.No.	Activities	Qty	Unit	Productivity	Unit	Duration (Hr)	Duration (Days)
1	Clearing of land	74445	cum	400	cum/hr	93.05625	12
2	Excavation						
	For vertical Valley Curve	3701.25	cum	60	cum/hr	61.6875	8
	For Horizontal Curve	5267.85	cum	60	cum/hr	87.7975	11
3	Embankment Construction	(Spreading+Compaction)					
	Transportation of Soil	116067.4	cum	5.5	cum/hr	2110.316364	264
	Construction of Embankment for Straight Alignment	53625	cum	400+100	cum/hr	134+178.75	39
	Construction of Embankment for Vertical Valley Curve	11261.3	cum	400+100	cum/hr	28.15+37.53	9
	Construction of Embankment for Vertical Summit Curve	13712.6	cum	400+100	cum/hr	29.53+36.52	9
	Construction of Embankment for Horizontal Curve	42367.35	cum	400+100	cum/hr	105.91+141.22	31
4	Subgrade Construction	(Spreading+Compaction)					
	Transportation of Soil	31107.38	cum	5.5	cum/hr	565.5887273	71
	Construction of Subgrade for Straight Alignment	14625	cum	400+100	cum/hr	36.56+48.75	11
	Construction of Subgrade for Vertical Valley Curve	3071.25	cum	400+100	cum/hr	7.67+10.23	3
	Construction of Subgrade for Vertical Summit Curve	3290.63	cum	400+100	cum/hr	8.23+11.56	3
	Construction of Subgrade for Horizontal Curve	10120.5	cum	400+100	cum/hr	25.30+33.73	8
5	GSB Construction	(Spreading+Compaction)					
	Transportation From Quarry	14423.77	cum	5.5	cum/hr	262.2503636	33
	GSB Production	14423.77	cum	60	cum/hr	240.3961667	30
	Construction of GSB for Straight Alignment	6781.3	cum	250+60	cum/hr	27.125+37.67	9

	Construction of GSB for Vertical Valley Curve	1424.06	cum	250+60	cum/hr	5.69+7.91	2
	Construction of GSB for Vertical Summit Curve	1525.78	cum	250+60	cum/hr	6.02+8.13	2
	Construction of GSB for Horizontal Curve	4692.63	cum	250+60	cum/hr	18.77+26.07	6
6	Bitumen Coat on GSB						
	For Straight Alignment	13562.6	sqm	1750	sqm/hr	7.750057143	2
	For Vertical Summit Curve	3051.56	sqm	1750	sqm/hr	1.743748571	1
	For vertical Valley Curve	2848.12	sqm	1750	sqm/hr	1.627497143	1
	For Horizontal Curve	9385.26	sqm	1750	sqm/hr	5.363005714	1
7	WMM Layer	(Spreading+Compaction+Paving)					
	Production	13964.02	cum	30	cum/hr	465.4673333	59
	Transportation	13964.02	cum	5.5	cum/hr	253.8912727	32
	For Straight Alignment	6531.3	cum	250+60+43	cum/hr	28.63+38.27+75.94	18
	For Vertical Summit Curve	1469.53	cum	250+60+43	cum/hr	5.89+8.02+17.08	4
	For vertical Valley Curve	1371.56	cum	250+60+43	cum/hr	6.36+8.54+18.53	4
	For Horizontal Curve	4591.63	cum	250+60+43	cum/hr	18.36+25.509+53.39	12
8	BM Layer	(Spreading+Compaction+Paving)					
	Production	2215.483	cum	35	cum/hr	63.29951429	8
	For Straight Alignment	1041.6	cum	175+40+40	cum/hr	5.95+26.04+26.04	9
	For Vertical Summit Curve	234.36	cum	175+40+40	cum/hr	1.339+5.85+5.85	2
	For vertical Valley Curve	218.736	cum	175+40+40	cum/hr	1.249+5.46+5.46	2
	For Horizontal Curve	720.787	cum	175+40+40	cum/hr	4.118+18.01+18.01	5
9	DBM Layer	(Spreading+Paving)					
	Production	4013.807	cum	35	cum/hr	114.6802	14
	For Straight Alignment	1887.1	cum	175+40	cum/hr	10.78+47.17	8
	For Vertical Summit Curve	424.586	cum	175+40	cum/hr	2.42+10.614	2
	For vertical Valley Curve	396.281	cum	175+40	cum/hr	2.23+9.62	2
	For Horizontal Curve	1305.84	cum	175+40	cum/hr	7.46+32.64	5
10	Bituminous Concrete	(Bitumen Coating+Asphalt Spreading)					
	For Straight Alignment	17025	sqm	1750+1500	sqm/hr	9.72+11.35	3
	For Vertical Summit Curve	3830.62	sqm	1750+1500	sqm/hr	2.55+2.188	1
	For vertical Valley Curve	3575.26	sqm	1750+1500	sqm/hr	2.04+2.38	1

	For Horizontal Curve	11781.3	sqm	1750+1500	sqm/hr	6.73+7.854	2
11	Earthern Shoulder						
	Transportation of Soil	3614.202	cum	5.5	cum/hr	65.71276364	9
	For Straight Alignment	1699.2	cum	200+100	cum/hr	8.496+5.664	2
	For Vertical Summit Curve	382.32	cum	200+100	cum/hr	1.911+1.274	1
	For vertical Valley Curve	356.832	cum	200+100	cum/hr	1.784+1.1894	1
	For Horizontal Curve	1175.85	cum	200+100	cum/hr	3.919+5.879	2
12	Paving of the Asphalt Surface	1810.609	cum	30	cum/hr	60.35363333	8