# RIGID PAVEMENT DESIGN AND ANALYSIS BY OPEN ROAD SOFTWARE

A PROJECT REPORT

*submitted in partial fulfilment for the requirement for the degree of*

**BACHELOR OF TECHNOLOGY**

**IN**

**CIVIL ENGINEERING**

*Under the supervision of*

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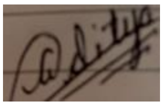
**MAY 2021**

# STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **"RIGID PAVEMENT DESIGN AND ANALYSIS BY OPEN ROAD SOFTWARE"** submitted for partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **DR Amardeep** Assistant Professor**,** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat**.** This work has not been submitted somewhere else for the prize of some other degree/recognition. I'm completely liable for the substance of my undertaking report.

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# CERTIFICATE

This is to ensure that the work which is being introduced in the task report titled "**RIGID PAVEMENT DESIGN AND ANALYSIS BY OPEN ROAD SOFTWARE**" in incomplete satisfaction of the necessities for the honor of the level of Bachelor of Innovation in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee College of Information Technology, Waknaghat** is a real record of work done by **SURAJ CHAUDHARY (171651), ADITYA ABROL (171603**) during a period from August, 2018 to May, 2019 under the oversight of **DR AMARDEEP**, Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above assertion made is right to the best of our insight.

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# ABSTRACT

Thruway configuration concerns the plan of street arrangement that adjusts to the site limitations and norms. The fundamental targets are to enhance proficiency and wellbeing while at the same time limiting expense and ecological harm. When a street/roadway engineer knows about the rudiments of street mathematical plan, the following stage to upgrade their worth is by learning a product for the use of these fundamental information. The goal of this task is import street mathematical plan into the product just as relate with the plan norms applied into the product. It will actually want to plan street mathematical from checking of overview information, even and vertical plan, super-height and creation of street cross segments. Bentley MXROAD is a high level, string-based displaying instrument that empowers the fast and precise plan of all street types. With MXROAD, you can rapidly make plan choices to fabricate the ideal street framework. After a last plan elective is chosen, you can computerize a significant part of the plan specifying measure, setting aside time and cash. At its center, MX ROAD utilizes 3D string-demonstrating innovation. An incredible yet brief technique for making 3D surfaces. The interoperable information base permits architects to make and clarify 3D venture models in the most mainstream AEC stages or in Windows. This implies that you can chip away at the venture inside one climate, save it, and open it consistently in another climate with no deficiency of information.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| AASHTO | American Association of State Highway & Transportation. |
| ASCII | American Standard Code for Information Interchange. |
| CRCP | Continuous Reinforced Concrete Pavement. |
| GEI | Google Earth Image. |
| IRC | Indian Road Codes. |
| ISI | Intermediate Sight Distance. |
| JPCP | Jointed Plain Concrete Pavement. |
| JRCP | Jointed Reinforced Concrete Pavement. |
| OSD | Overtaking Sight Distance. |
| PCP | Pre-stressed Concrete Pavement. |
| SSD | Stopping Sight Distance. |

# CHAPTER 1

# INTRODUCTION& OBJECTIVE

## 1.1 GENERAL INTRODUCTION

- Pavements are essential mean of transportation. These give human admittance to better places. Various sorts of streets are made in a nation to satisfy prerequisites, for example motorways are made to give speedy and safe access between essential urban communities, towns, towns and so on.
- Highways are constructed to connect two or more cities, rural areas have completely different variety of road to attach farm lands with the town or cities. Roads offer access to the outside world or the store round the corner. Roads take farm produce to cities markets and children to school. Roads are the passage of life's activities.
- The advancement of a compelling street transport framework is the essential need of any country. The updating of existing street network framework is likewise fundamental as the traffic on metropolitan and country interstates contacts to immersion level throughout some stretch of time.
- The road development projects being highly capital intensive involve very high degree of attention by the project authorities as well as by the consultants, engineers and contractors. Any slip-up may bring about wastage of millions, which might have been kept away from. Typically the arrangement and the asphalt piece choose the expense of an interstate undertaking and for this work the best experienced labor and the best accessible devices should be conveyed.
- And in todays life we are moving towards the digitalisation so, from now onwards we are going to use more and more software. For road development plan there is large number of software like Micro station, Civilstrom, LumenRT, Open Road Software these are some software which are used for civil engineering road work and we are going to work on Open Road Software. We are using this software because this is the only software which provide design, plan, cross section, 3D view, 2D view and it can take data from any file.

## 1.2 OBJECTIVE

Analysis of a hilly terrain which is in District Kishtwar of Jammu And Kashmir.

Design of 2 Lane Rigid Pavement of length 4.8 KM on hilly terrain of District Kishtwar of Jammu And Kashmir.

- Horizontal Design.
- Vertical Design.
- Speed Design.
- Superelevation Design.
- Cross Slope.
- Template Design.

Cost Estimation for Rigid Pavement of length 4.8 KM according to JKSR-2020

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 GENERAL

Various studies and work has been done on Open Road Software to make road design work easy. We study some papers and try to find out the critical observations or conclusions to make our work easy, efficient and to reduce the cost of construction. From these studies the most important thing is that in Open Roads Software with very much perfection and ease way anyone can design alignment, horizontal geometry, vertical gradient, superelevation. Also study some road design paper to make curves more smooth in hilly regains.

## 2.2 STUDIES AND CRITICAL OBSERVATION

**"SAFE DESIGN ON SMALL RADIUS CURVE OF MOUNTAIN ROAD."** by Runwei you, Journal of Applied mechanics and materials, 2014.

Critical observations:

1. Bend of small radius curve is accident-prone locations.
2. The reasons for accidents can be Wrong visual response, large or small angel of curve, Inadequate widening and Inappropriate super elevation.
3. Then again Bentley offers a plenitude of manuals and instructional classes for MX Road programming. Bentley additionally offers specialized help and a broad online information base for MX Road.
4. Increasing the superelevation i.e super elevation of outside lane should be increased relative to inner lane.
5. The reasons for many traffic accidents, when the human and car factors were ruled out, eventually fell on road factors. The majority of the mishaps were brought about by preposterous street direct plan.

**“DESIGN OF ROAD PROJECT USING HEAD AND MX SOFTWARE.”** Theis by Sachin Dass under the guidance of DR. Praveen aggerwal and DR. S.N. Sachdeva Department of Civil Engineering National Institute of Technology Kurukshetra (December 2009) they design road project by both Head and MX Software.

Critical observation:

1. Road design models in MX Road and HEADS are very similar. They differ only by their functions and abilities. The use of different software products makes it possible to solve different complex design tasks.
2. Bentley MX Road software is more flexible since it can be operated in MicroStation/AutoCAD graphical environment or in the environment of Windows operating system without requiring an additional CAD platform whereas HEADS uses its own CAD engine.
3. Both the software lack dynamic relationship of the project data, i.e. a change in one object does not cause an automatic renewal and representation of the other related project data. If a change or modification is to be incorporated in the design model at any stage then the model reports need to be generated again to incorporate the desired change in the design.
4. In the event that a Design Engineer joins the firm in the center of the task then it is all the more straightforward the means in HEADS as report documents are at the same time produced when a model is run in the default envelope of the venture while in MX no such reports are created.
5. The amount of reference manuals and training available in case of HEADS is very limited. The tutorial, which can be found on the HEADS website, is an outline of the modules incorporated into the software. Then again Bentley offers a bounty of manuals and instructional classes for MX Road programming. Bentley likewise offers specialized help and a broad online information base for MX Road.

**“GEOMETRIC DESIGN OF A HIGHWAY USING MX ROAD”** Journal by mohd. Khaja Nazimuddin, Mir Iqbal Faheem and Mohd. Minhajuddin Aquil (December 2017)

Critical observations:

1. Mathematical plan concerns the plan of street arrangement that adjusts to the site imperatives and guidelines. The fundamental targets are to advance proficiency and wellbeing while limiting expense and natural harm.
2. The goal of this examination is import street mathematical plan into the product just as relate with the plan guidelines applied into the product. It will actually want to plan street mathematical from checking of overview information, level and vertical plan, super-rise and creation of street cross areas.
3. Bentley MXROAD is an advanced, string-based demonstrating instrument that empowers the fast and precise plan of all street types. With MXROAD, you can rapidly make plan choices to fabricate the ideal street framework.
4. The interoperable data set permits architects to make and explain 3D task models in the most well known AEC stages or in Windows. This implies that you can chip away at the task inside one climate, save it, and open it flawlessly in another climate with no deficiency of information.
5. We can likewise change our arrangement our plan our way as indicated by our need by seeing GIS or existing territory overview record.
6. In this study the proposed arrangement experiences least level bend span at two minor intersections, where the paces are confined to least. Restricting angle esteems are embraced for not many areas where site limitation wins.
7. The acquired base traffic volume information has been projected to a time of 15 years (2017-2032). High plan accuracy and saving in time were accomplished by utilizing MXROAD.

**“ROAD TRAFFIC ACCIDENTS IN HILLY REGAIONS OF NORTHEN INDIA: WHAT HAS TO BE DONE?”** Journal by Anil Kumar Joshi, Chitra Joshi, Mridu Singh, Vikram Singh, 2014.

Critical observations:

1. Purposes behind mishaps in sloping district are inadequately planned bends in the street, dazzle bends, ill-advised position of street signs or lights.
2. Mishaps can likewise happen if a street is appropriately planned and built however isn't painstakingly kept up.
3. Imperfect support concerns are potholes and street disintegration, broken guiderails, inability to eliminate street garbage and inability to keep up signs and light controls.

**"GEOMETRIC DESIGN OF A HIGHWAY USING MXROAD."** Journal by Mr. Sreenatha, Mr. Ramakant, Mr. Mohit Akshay H S Assistant professor, School of Civil Engineering, REVA University.(3 November 2018)

Critical observations:

1. The venture is about Design of Urban Road utilizing MXROAD Software and is accomplished for a stretch of 1.51 km from Devegowda Circle to Nice Road by means of Kerekodi Road. The goal of this investigation is to import street plan into the product just as relate with plan norms applied into the product. To know the current state of the street cross sectional components, street stock is finished.
2. Overview information is removed from GIS i.e., Google Earth and street configuration is finished utilizing MXROAD programming which is a development string base apparatus that empowers quick planning of all street type with precision.
3. In street plan, mathematical plan which comprises of arrangement (both flat and vertical), carriageway, super height and additional broadening alongside street cross sectional components which comprises of shoulder, kerbs, borderlines and pathway observed plan standard according to IRC: 86-1983. Earthwork is done so that the cut and fill percent gets generally coordinated. The adaptable asphalt configuration is done according to IRC: 37-2012 and for that traffic volume overview and CBR test is finished. A nitty gritty report of each section is created effortlessly utilizing MXROAD.
4. As 27 km of street is construct every day in India. Thus, receiving programming in this training will streamline exactness and wellbeing while at the same time limiting the expense and time.
5. By this we came to realize that to build the driver's and traveler's solace capacity on each bend, super rise must be expanded and augmenting is likewise need to increment dependent upon some level is recommended.

**"INFLUENCE OF DIFFERENTIAL SETTLEMENT ON PAVEMENT STRUCTURE OF WIDENED ROADS BASED ON LARGE SCALE MODEL TEST"** Journal of Rock mechanics and Geotechnical Engineering by Xiaolin 2011

Critical observations:

1. Huge scope model test was performed to dissect the impact of differential setting among new and old subgrade under stacking conditions.
2. Use of geogrid to the graft, be that as it may, can ease the differential settlement and further diminish its impact.
3. The strain of asphalt structures increment easily with the development of differential settlement.
4. The controllable settlement stage, included by high controllability, is an cutting edge innovation for the reproductions of differential settlement between the new and the old subgrades.

**"DESIGN OF SUB-ARTERIAL URBAN ROAD USING MXROAD SOFTWARE."**
Journal by Ali Ashraf, Nishant Singh, Yashraj Shrivastava, JS Vishwas(May 2018)

Critical observations:

1. The undertaking is about Design of Urban Road utilizing MXROAD Software and is accomplished for a stretch of 1.51 km from Devegowda Circle to Nice Road through Kerekodi Road. The goal of this investigation is to import street plan into the product just as relate with plan norms applied into the product. To know the current state of the street cross sectional components, street stock is finished.
2. Review information is extricated from GIS i.e., Google Earth and street configuration is finished utilizing MXROAD programming which is a development string base apparatus that empowers fast planning of all street type with exactness.
3. In pavement plan, mathematical plan which comprises of arrangement (both even and vertical), carriageway, super rise and additional broadening alongside street cross sectional components which comprises of shoulder, kerbs, borderlines and trail adhered to plan standard according to IRC: 86-1983. Earthwork is done so that the cut and fill percent gets generally coordinated. The adaptable asphalt configuration is completed according to IRC: 37-2012 and for that traffic volume overview and CBR test is finished. An itemized report of each fragment is produced effortlessly utilizing MXROAD.
4. As 27 km of street is assemble every day in India. Thus, receiving programming in this training will upgrade precision and wellbeing while at the same time limiting the expense and time.
5. By this we came to realize that to build the driver's and traveler's solace capacity on each bend, super height must be expanded and augmenting is likewise need to increment dependent upon some level is recommended.

# CHAPTER 3

# METHODOLOGY AND GEOMETRY DESIGN

## 3.1 INTRODUCTION ABOUT RIGID PAVEMENT

A path way asphalt is a construction comprising of superimposed layers of handled materials over the common soil sub-level, whose essential capacity is to circulate the applied vehicle burdens to the sub-level. The asphalt design ought to have the option to give a surface of satisfactory riding quality, sufficient pallet opposition, good light reflecting attributes, and low clamor contamination. A definitive point is to guarantee that the communicated pushes because of wheel load are adequately diminished, so they won't surpass bearing limit of the sub-grade. Two sorts of asphalts are by and large perceived as filling this need, in particular adaptable asphalts and inflexible asphalts. This part gives an outline of asphalt types, layers, and their capacities, and asphalt disappointments. Ill-advised plan of asphalts prompts early disappointment of asphalts influencing the riding quality.

Requirements of a pavement

- An ideal asphalt should meet the accompanying prerequisites: Sufficient thickness to distribute the wheel load stresses to a safe value on the sub-grade soil,
- Sufficient thickness to circulate the wheel load stresses to a protected worth on the sub-grade soil,
- Structurally solid to withstand a wide range of stresses forced upon it,
- Adequate coefficient of grinding to forestall sliding of vehicles,
- Smooth surface to give solace to street clients even at rapid,
- Dust verification surface so that traffic wellbeing isn't impeded by diminishing perceivability,

- Impervious surface, so that sub-grade soil is all around secured, and
- Long plan existence with low support cost.

The asphalts can be arranged dependent on the primary execution into two, adaptable asphalts and inflexible asphalts. In adaptable asphalts, wheel loads are moved by grain-to-grain contact of the total through the granular construction. The adaptable asphalt, having less flexural strength, acts like an adaptable sheet (for example bituminous street). Actually, in inflexible asphalts, wheel loads are moved to sub-level soil by flexural strength of the asphalt and the asphalt acts like an unbending plate (for example concrete solid streets). Moreover, composite asphalts are additionally accessible. A slim layer of adaptable asphalt over unbending asphalt is an ideal asphalt with most alluring qualities. Nonetheless, such asphalts are seldom utilized in new development due to significant expense and complex examination required.

**Rigid pavements**

In flexible asphalts have adequate flexural solidarity to send the wheel load stresses to a more extensive region beneath. An average cross segment of the unbending asphalt is appeared in Figure. Contrasted with adaptable asphalt, unbending asphalts are put either straightforwardly on the readied sub-grade or on a solitary layer of granular or settled material. Since there is just one layer of material between the solid and the sub-grade, this layer can be called as base or sub-base course.

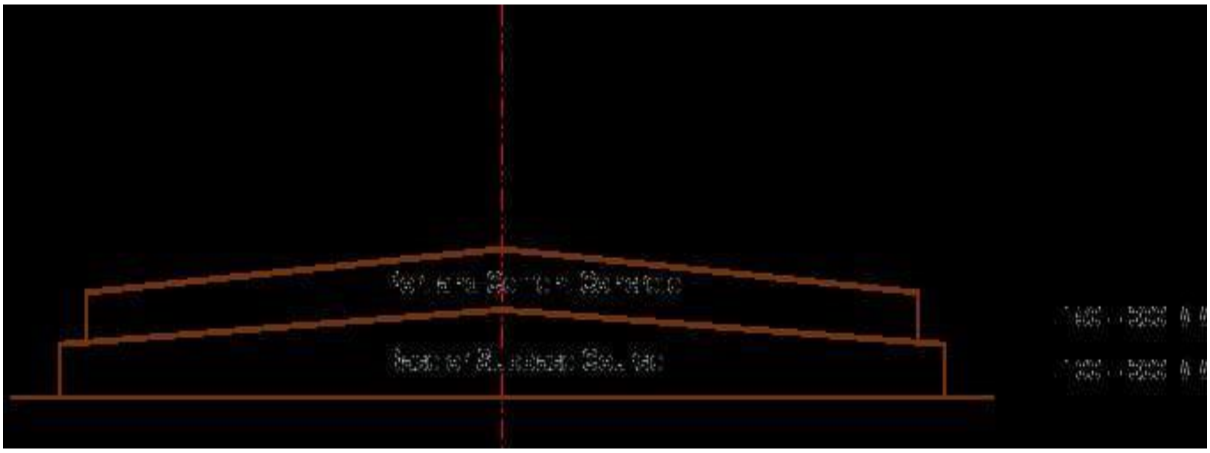

**Figure 3.1** Rigid pavement

In inflexible asphalt, load is circulated by the section activity, and the asphalt acts like a versatile plate laying on a thick medium. Unbending asphalts are built by Portland concrete cement (PCC) and ought to be examined by plate hypothesis rather than layer hypothesis, accepting a versatile plate laying on gooey establishment. Plate hypothesis is an improved on adaptation of layer hypothesis that expects the solid section as a medium thick plate which is plane prior to stacking and to stay plane in the wake of stacking. Twisting of the piece because of wheel burden and temperature variety and the subsequent pliable and flexural stress.

**Types of Rigid Pavements**

- Rigid pavements can be classified into four types:
- JPCP
- JRCP
- CRCP
- PCP

**Jointed Plain Concrete Pavement**:

are plain concrete solid asphalts developed with firmly separated compression joints. Dowel bars or total interlocks are regularly utilized for load move across joints. They ordinarily has a joint dividing of 5 to 10m.

**Jointed Reinforced Concrete Pavement:**

In spite of the fact that fortifications don't improve the underlying limit altogether, they can definitely expand the joint dividing to 10 to 30m. Dowel bars are needed for load move. Fortifications help to keep the chunk together even after breaks.

**Continuous Reinforced Concrete Pavement:**

Complete disposal of joints are accomplished by support.

**Failure criteria of rigid pavements**

Customarily exhaustion breaking has been considered as the major, or just standard for inflexible asphalt plan. The permissible number of burden reiterations to cause weakness breaking relies upon the pressure proportion between flexural pliable pressure and solid modulus of burst. Of late, siphoning is distinguished as a significant disappointment rule. Siphoning is the discharge of soil slurry through the joints and breaks of concrete solid asphalt, caused during the descending development of section under the hefty wheel loads. Other significant kinds of misery in unbending asphalts incorporate blaming, spalling, and decay.

## 3.2 INTRODUCTION ABOUT SOFTWARE

Access 3dimensional displaying, assessment, asphalt format, and development pushed engineering, across the board programming. MXROAD Suite makes work speedier, more astute, and more efficiently. MXROAD Suite empowers to improve design top notch by utilizing combining conventional designing work processes of plan, profile, and go-segments with progressive 3dimensional demonstrating age basically dependent on parametric connections and requirements.

Other programming in structural designing can't give the plan, the cross segment, the 2D view, the 3D view every one of these documents in a single programming. The most beneficial thing about this product is that it can take document from any arrangement it can take record from miniature station, it can take information from review record, it can likewise take information from google earth picture, in the event that we need to import creep document here we can likewise import that document here and this product additionally send out document in any format .In 2D sheet record we will investigate landscape and in 3D sheet document we will accomplish configuration work. The main thing about this product is it is an astounding string-based displaying cost in common work.

String-A string is a progression of focuses and might be joined by straight or bend fitted lines. A string of some structure addresses all surfaces and highlights. Any line that can be drawn in horizontal and vertical portrayal is a string.

Model-A model is a gathering of strings characterizing a surface. Models can record various sorts of information, for example, ground surface, a progression of highlights, an organization of information, or simply focuses.

### 3.2.1 Role in Industry

• This programming renders all that one requirement in transportation and common plan projects. It upholds in overview and information obtaining for a wide range of the information field. It performs following capacities inside the business.

• It guarantees that task is designed which is extremely basic for the 3Dmodel.

• It permits clients to share data across different groups, areas, and order in thought to security and exactness.

• Enables configuration time perception to see the plan on the fly and set aside cash by keeping away from programming and staff prerequisite.

### 3.2.2 Capabilities of OPEN ROAD SOFTWARE.

• Acquire and incorporate surveys

• Create horizontal and vertical alignments

• Create profiles and cross sections

• Create project base maps

• Design and analyse corridors

• Visualize designs

• Simulate vehicle path movement

• Incorporate third-party models in civil designs

## 3.3 GEOMETRIC DESIGN

The Geometric Design of a roadway manages the measurements and format of noticeable highlights of the interstate like arrangement, sight distances and crossing points. The calculations of expressway ought to be intended to furnish ideal effectiveness in rush hour gridlock tasks with greatest wellbeing at sensible expense.

Mathematical plan of interstate arrangements with following components:

- Cross sectional components
- Sight distance contemplations
- Horizontal arrangement subtleties
- Vertical arrangement subtleties
- Intersection components

### 3.3.1 SIGHT DISTANCE

**Stopping Sight Distance (SSD)**

It is the base sight distance apparent to a driver at any point, that has adequate length to stop the vehicle going at configuration speed with no odds of crash.

SSD is given by: SSD = Lag distance (L) + Breaking distance (B)

SSD= Vt+ v^(2)/gf

**Overtaking Sight Distance (OSD)**

It is the base sight distance noticeable to a driver proposing to overwhelm a sluggish vehicle with wellbeing against impact with traffic from inverse heading. Or on the other hand, it tends to be characterized as the distance with his eye level at 1.2m above street surface from where he can see top of an item.

A = Overtaking vehicle

B = Overtaken vehicle

C = Oncoming vehicle

B C = Oncoming vehicle

1d = distance travelled by A during reaction time

2 d = distance travelled by A during overtaking distance travelled by A during overtaking
3 d = distance travelled by C during overtaking distance travelled by C during overtaking

T = Time for overtaking

T = 4S^(1/2)/a

OSD = 1d+2d+3d

**Sight Distance at Intersection**

At uncontrolled crossing points, there ought to be adequate perceivability at any rate equivalent to SSD of the streets. IRC suggested sight distances at crossing points. **Intermediate Sight Distance**

In situations where OSD can't be given, ISD is given to offer restricted surpassing chances to fastmoving vehicles.

OSD>ISD>SSD

ISD=2SSD

### Head Light Sight Distance

It is the sight distance apparent to a driver during night under enlightenment of front head lights. This is basic at inclinations.

### 3.3.2 CROSS SECTION ELEMENTS

The highlights of the cross-segment of the asphalt impacts the existence of the asphalt just as the riding solace and wellbeing. Camber, kerbs, and math of different cross-sectional components are significant angles to be considered in such manner.

### Camber

Camber or cant is the cross slant gave to raise widely appealing surface the cross over way to empty off downpour water out of street surface. The targets of giving camber are: Surface security particularly for rock and bituminous streets.

### Kerb

A kerb is the edge where a raised walkway (asphalt in British and Singaporean English; asphalt or pathway in Australian English) or street middle/focal reservation meets a road or other street.

### 3.3.3 Horizontal Alignment Design

The flat plan of a street is an arrangement see and ordinarily comprises of a progression of straights and roundabout bends. A blend of elements, for example, plan speed, range of roundabout bends, type and length change bends, superelevation and extending of asphalt on bends are utilized to help the roundabout development of a vehicle. The arrangement should empower reliable, protected and smooth development of vehicles working at configuration speed.

**Radius of Horizontal Curve**

The sweep of the even bend is a significant plan part of the mathematical plan. The greatest agreeable speed on a flat bend relies upon the sweep of the bend. In spite of the fact that it is feasible to plan the bend with greatest superelevation and coefficient of rubbing, it isn't attractive in light of the fact that re-arrangement would be required if the plan speed is expanded in future. Thusly, a decision least range Rruiing can be determined by expecting most extreme superelevation and coefficient of grinding.

Rruling =v^(2)/g(e+f)

Where, v = configuration speed, m/s

g = speed increase because of gravity m/s^ 2

e = superelevation, percent

f = coefficient of grating, percent

Preferably, the sweep of the bend ought to be higher than Rrulling. Notwithstanding, exceptionally huge bends are likewise not alluring. Setting out huge bends in the field gets troublesome. What's more, it additionally upgrades driving strain.

**Extra Widening**

Additional extending alludes to the extra width of carriageway that is needed on a bended segment of a street far beyond that needed on a straight arrangement. This enlarging is done because of two reasons: the first and most significant is the extra width needed for a vehicle arranging a flat bend (off following) and the second is due to the propensity of the drivers to employ away from the internal edge of the carriageway as they drive on a bend. The first is alluded as the mechanical augmenting and the second is known as the mental broadening. These are examined in detail underneath.

1.Mechanical Widening

$$W_m = nl^{(2)}/2R$$

2.Psychological Widening

$$W_{ps} = v/2.64(R)^{(1/2)}$$

Therefore, the total widening needed at a horizontal curve We is

$$W_e = W_m + W_{ps}$$

### 3.3.4 VERTICAL ALIGNMENT DESIGN

Another significant element in street configuration is the upward arrangement. This is the height of the focal line of the flat arrangement. The upward arrangement of a street comprises of slopes (straight lines in an upward plane) and vertical bends. The upward arrangement is typically drawn as a profile, which is a diagram with rise as upward hub and the level distance along the middle line of the street as the even hub. Flat round bend is utilized to associate even straight stretches of street, vertical bends interface two angles. Vertical bends are either raised or inward. The previous is known as a culmination bend, while the last is known as a valley bend. This part covers a conversation on inclination and highest point bends. It incorporates level stretches, inclines or evaluations and vertical bends (culmination and valley bends). Numerous variables impact the upward arrangement configuration are vehicle speed, speed increase, deceleration, halting distance, sight distance and solace in vehicle development at rapid.

**Gradient**

Inclination is the pace of rise or fall along the length of the street regarding the even. It is communicated as a proportion of 1 in N (1 vertical unit to N even units) Before concluding the slopes, the development cost, vehicular activity cost and the pragmatic issues in the site additionally must be thought of. Generally steep inclinations are kept away from quite far due to the trouble to climb and expansion in the vehicle activity cost.

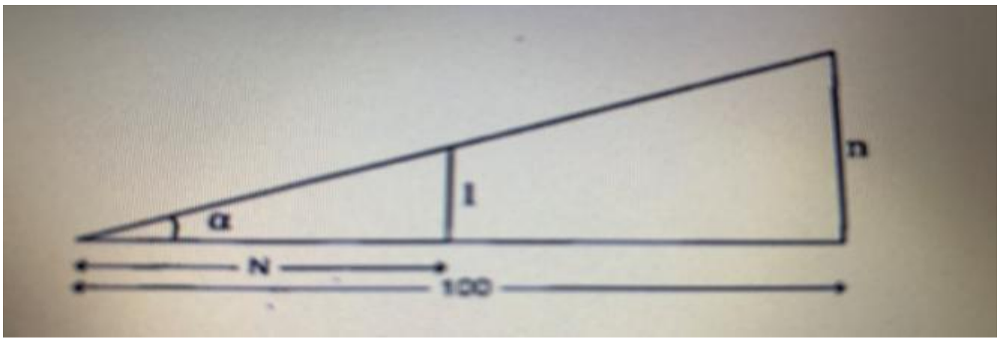


**Figure 3.2** Gradient

Gradients are divided into the following categories:

- Ruling gradient
- Limiting gradient
- Exceptional gradient

| Terrain | Ruling | Limiting | Exceptional |
| --- | --- | --- | --- |
| Plain/Rolling | 3.3 | 5.0 | 6.7 |
| Hilly | 5.0 | 6.0 | 7.0 |
| Steep | 6.0 | 7.0 | 8.0 |

**Figure 3.3**Gradient Table

# CHAPTER 4
# OPEN ROAD SOFTWARE

## 4.1 INSTALLATION OF IRC

Open Road software is American based software. It works American code (AASHTO Design Standards).


**Figure 4.1** Working window

This box is shown in top of this window. The first part where training and example is written is called as work space and the second part is called as work set. As we click on this then work space and work set is opened.

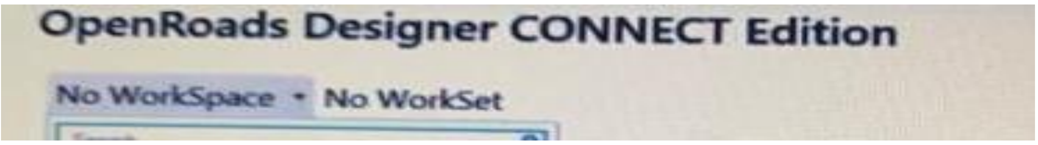


**Figure 4.2** Working window

In workspace set the Design units and in workset the work which has to be done after.

Now all the work will done in American standards.

So basic and most important thing is download and install IRC codes files which is supported in this software. After installing IRC codes when we open our workspace it will open like this

**Figure 4.3**Working window

Now from work space set India Standards for further work. Now all the work will done in Indian standards.

Now from work set give name to the project and then start our work.

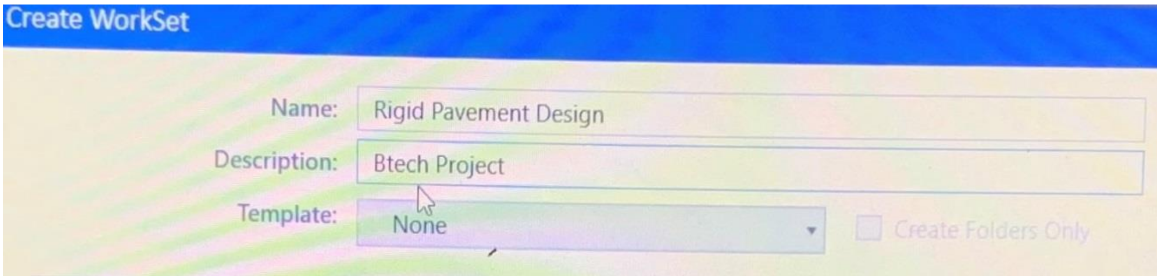


**Figure 4.4** Working window

## 4.2 TERRAIN IMPORT

Open Road Software has 2D and 3D both sheet files

First import the terrain in 2D sheet file in 2D sheet file there is analysis of terrain part and then 3D sheet file in 3D sheet file there is design of pavement.

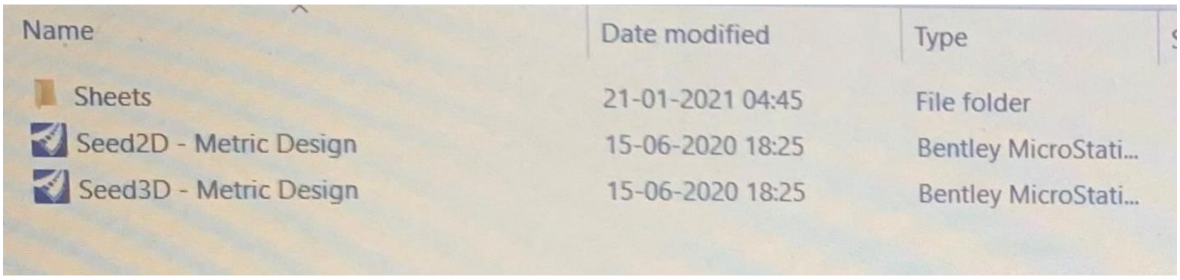


**Figure 4.5** Working window

Now 1st open 2D file and import the terrain in 2D sheet file do analysis part and then attach that file direct in 3D sheet file for final pavement design.

So, 2D sheet file

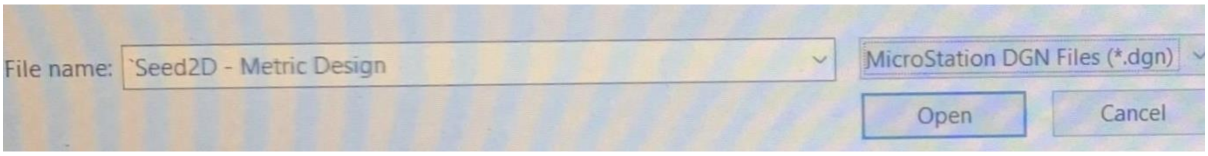


**Figure 4.6** Working window

And then open 2D sheet for analysis work

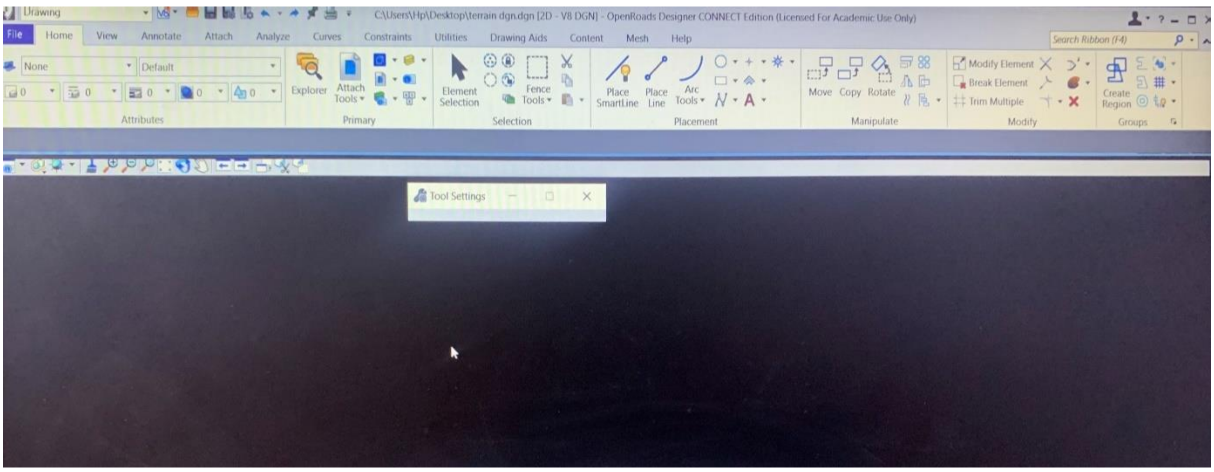


**Figure 4.7** Working window

1st in 2D sheet file first select software in Open Roads Modeling.

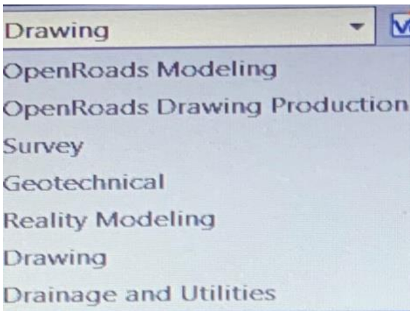


**Figure 4.8** Working window

There is multiple options but select Open Road Modeling because in this project the work is done on design of pavement.

From Additional Methods import terrain file.

In additional methods from Create Terrain Model from Ascii File import terrain here in 2D sheet file.

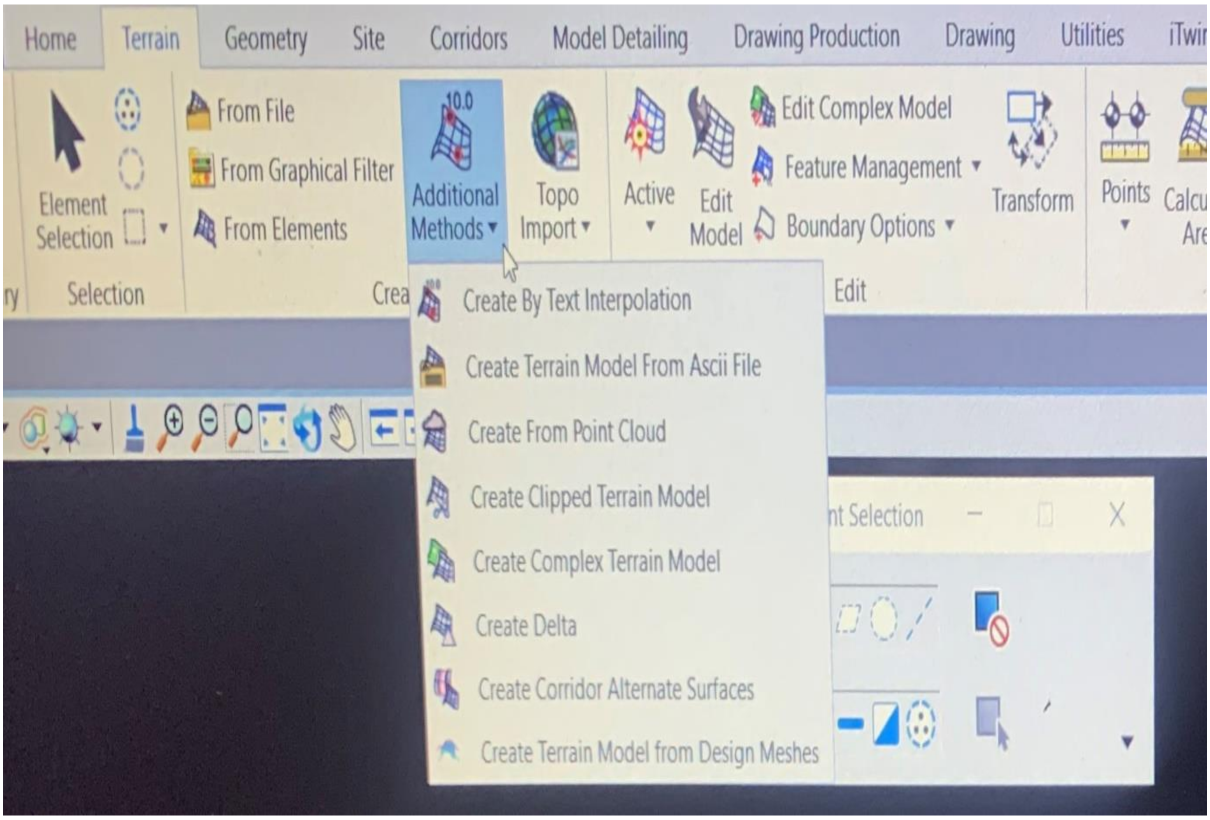


**Figure 4.9** Working window

The terrain file on which work has to be done or this is raw data for this software.

```
B   88,615995.8728,201339.9392,1441.9685
B   87,615996.5708,201343.7459,1441.6508
B   86,615997.2634,201346.7128,1441.4880
B   85,615998.5426,201350.1215,1441.3405
B   84,616000.0839,201352.7224,1441.1190
B   83,616001.8632,201354.7120,1441.0461
B   82,616005.3527,201357.1002,1440.8275
B   81,616008.9373,201358.3249,1440.6920
B   80,616031.6525,201363.2479,1439.9622
B   79,616040.5603,201367.8114,1439.4044
B   78,616052.8371,201372.9809,1439.5301
B   77,616060.0534,201376.8587,1439.2464
B   76,616069.4029,201383.1339,1438.7511
B   75,616080.4659,201390.5269,1438.1220
B   74,616088.1959,201396.0859,1437.4863
B   73,616094.9719,201401.6060,1436.7503
B   72,616100.4162,201406.1899,1436.2596
B   71,616104.6533,201410.9698,1435.9210
SP 1,616045.3943,201340.4194,1445.7621
B   70,616104.3865,201411.2709,1436.7230
B   69,616105.8963,201414.0236,1436.5750
B   68,616106.4543,201415.3028,1436.4458
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B   61,616106.3217,201433.9085,1433.7157
B   60,616088.7272,201450.2560,1432.2297
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B   58,616082.3087,201457.1512,1433.0184
B   57,616080.4549,201459.1425,1432.8444
B   56,616077.4753,201461.4933,1432.8943
B   55,616071.4934,201465.8536,1432.6203
B   54,616063.6990,201471.3913,1432.2502
B   53,616055.2455,201472.7969,1432.1056
B   52,616051.0722,201473.1880,1432.1342
B   51,616043.0541,201471.8455,1431.7580
B   50,616028.2798,201473.7268,1431.4234
B   49,616023.9247,201472.7769,1431.1937
B   48,616019.6772,201472.9082,1431.0184
B   47,616007.9721,201470.3993,1430.6306
B   46,616001.6429,201467.8021,1430.8453
B   45,615996.1575,201465.5088,1430.5464
B   44,615980.4217,201453.0515,1430.5571
B   43,615973.9619,201443.5133,1430.5752
```

**Figure 4.10** Terrain file

```
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SP 2,616036.9145,201467.6036,1432.1736
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B   40,615964.8798,201435.5523,1431.1676
B   39,615961.1819,201432.4146,1430.6703
B   38,615958.8359,201429.5135,1430.8199
B   37,615955.4534,201426.3144,1430.8252
B   36,615952.1610,201423.1134,1431.0421
B   35,615949.0293,201419.0776,1430.7164
B   34,615947.7297,201414.8276,1430.7794
B   33,615946.9979,201410.4261,1430.8218
B   32,615947.0859,201406.6980,1431.0309
B   31,615946.3547,201402.9937,1431.2531
B   30,615945.5621,201399.5726,1431.3662
B   29,615943.2950,201396.1845,1431.5810
B   28,615940.0410,201394.3804,1431.6648
B   27,615937.2427,201391.0308,1432.0148
B   26,615928.3657,201387.2792,1431.9502
B   25,615923.8645,201386.6930,1431.4966
B   24,615918.7541,201388.1396,1429.7985
B   23,615915.8045,201387.9739,1428.3478
B   22,615913.3694,201385.3860,1427.4109
B   21,615911.0462,201383.5976,1426.7592
B   20,615911.0212,201380.2570,1426.3121
B   19,615911.4251,201377.2702,1426.5116
B   18,615911.2361,201374.4117,1425.5293
B   17,615913.8055,201371.5630,1426.4367
B   16,615916.3898,201369.1553,1427.4635
B   15,615919.7321,201366.0900,1428.2768
B   14,615925.6336,201363.2408,1429.7173
B   13,615928.4862,201362.7837,1430.5146
B   12,615930.9566,201361.8516,1431.0567
B   11,615933.6523,201359.9856,1431.7342
B   10,615936.1240,201357.9373,1432.6738
B   9,615937.0494,201354.7116,1432.6729
B 9 ,615937.0943,201354.7882,1432.6715
B 8 ,615934.6898,201339.0107,1433.6738
B 7 ,615934.2567,201336.9575,1434.5264
B 6 ,615934.6627,201331.8741,1434.8764
B 5 ,615932.3527,201326.5578,1435.1757
B 4 ,615925.2226,201320.1589,1435.0580
B 3 ,615919.4096,201313.5250,1434.2833
B 2 ,615914.3266,201307.1313,1434.9089
B 1 ,615910.2337,201300.3730,1436.2383
33 11,615803.7810,200868.2880,1585.0480
```

**Figure 4.11** Terrain file

```
PATHE  YARD,615925.9290,201387.0820,1431.7440
TOP ROAD R48 A3,616159.5889,201221.9927,1523.8636
TOP ROAD R48 A2,616159.7453,201222.8052,1523.8046
TOP ROAD R48 A1,616159.8112,201226.3121,1523.7446
TOP ROAD R40 A3,616152.2756,201221.7557,1524.6249
TOP ROAD R40 A2,616152.2182,201223.1375,1522.6324
TOP ROAD R40 A1,616152.1458,201225.9119,1522.5332
TOP ROAD R30 A3,616142.7695,201223.1783,1525.1514
TOP ROAD R30 A2,616144.6445,201225.1163,1521.0659
TOP ROAD R30 A1,616142.4263,201228.2721,1520.5512
TOP ROAD R20 A3,616132.6539,201222.9619,1524.4138
TOP ROAD R20 A2,616135.8321,201226.5700,1519.6601
TOP ROAD R20 A1,616132.2042,201230.2515,1518.9649
TOP ROAD R10 A2,616122.7723,201223.2826,1522.0253
TOP ROAD R10 A1,616122.4651,201228.9882,1518.3939
TOP ROAD R0 A2,616112.4285,201224.4062,1520.7508
TOP ROAD R0 A1,616112.5157,201230.5112,1516.9842
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TS R85 A5,616009.2000,201219.2473,1510.5066
TS R85 A4,616007.5816,201222.1060,1507.6969
TS R85 A3,616006.0598,201225.0423,1504.4926
TS R85 A2,616006.6003,201227.7935,1500.5609
TS R85 A1,616006.5523,201230.9673,1500.0975
TS R75 A7,616015.9863,201231.2593,1501.6312
TS R75 A6,616018.3733,201227.5407,1501.6470
TS R75 A5,616016.3632,201226.4835,1503.5649
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TS R60 A4,616033.7460,201224.8820,1507.6840
TS R60 A3,616033.2450,201226.1309,1505.2542
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TS R60 A1,616030.7504,201232.0400,1502.8442
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TS R45 A5,616045.1290,201231.4556,1503.2371
TS R45 A4,616045.0373,201228.8974,1506.6914
TS R45 A3,616046.1979,201227.1488,1509.0011
TS R45 A2,616047.1644,201221.4111,1511.7789
TS R45 A1,616048.1138,201218.0707,1514.5289
TS R30 A5,616061.9868,201223.3553,1515.4177
TS R30 A4,616061.1961,201228.3337,1512.3505
TS R30 A3,616060.5190,201233.6220,1508.9145
TS R30 A2,616059.4348,201238.4965,1503.5664
TS R30 A1,616058.7702,201242.7085,1503.9059
TS R15 A6,616072.2469,201248.2133,1504.4004
TS R15 A5,616073.7296,201243.8881,1504.4419
TS R15 A4,616072.9788,201241.8471,1506.4071
```

**Figure 4.12** Terrain file

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TS R15 A3,616073.4602,201239.6206,1508.9290
TS R15 A2,616074.5913,201234.3278,1512.9414
TS R15 A1,616076.5900,201227.6869,1516.0116
TS R0 A6,616087.0184,201252.2036,1504.4501
TS R0 A5,616089.1393,201245.4594,1504.2385
TS R0 A4,616089.7886,201241.1399,1507.5700
TS R0 A3,616090.1478,201238.6742,1511.2482
TS R0 A2,616090.8220,201234.7564,1513.0828
TS R0 A1,616091.1978,201230.8394,1516.6113
R 180 A4 ,616011.7752,201225.9480,1504.0445
R 180 A3 ,616006.7097,201226.4596,1502.6523
R 180 A2 ,616008.4035,201227.3122,1500.7892
R 180 A1 ,616007.6104,201231.2142,1500.2649
R165 A6,616023.4729,201223.1606,1509.0436
R165 A5,616024.1610,201224.2171,1507.1531
R165 A4,616022.6360,201224.8465,1505.6712
R165 A3,616020.6785,201225.7611,1503.6542
R165 A2,616022.2186,201226.7816,1502.2569
R165 A1,616021.0785,201230.8348,1502.3580
R 150 A6,616034.3906,201223.2298,1511.0553
R 150 A5,616037.0996,201224.9630,1508.6270
R 150 A4,616035.4791,201225.7622,1506.2559
R 150 A3,616036.9122,201227.2563,1504.7453
R 150 A2,616037.9219,201229.2441,1502.9096
R 150 A1,616036.2114,201232.6478,1502.8093
R135 A5,616053.8326,201232.8851,1508.5046
R135 A4,616054.0711,201233.7818,1507.1979
R135 A3,616056.9900,201235.5730,1505.6456
R135 A2,616052.6776,201234.5571,1503.4226
R135 A1,616050.4586,201238.2048,1503.5081
R120 A5,616065.8618,201238.0427,1508.3285
R120 A4,616067.6211,201240.4323,1506.6244
R120 A3,616066.1122,201241.4640,1503.8622
R120 A2,616065.5350,201243.1757,1503.9728
R120 A1,616064.7734,201245.1020,1504.0631
R110 A8,616074.0194,201229.2570,1514.9882
R110 A7,616077.2204,201240.5168,1510.0419
R110 A6,616077.2030,201242.3964,1508.0803
R110 A5,616076.3938,201242.9562,1506.1380
R110 A4,616075.7220,201243.9632,1504.5874
R110 A3,616075.5136,201245.9853,1504.4714
R110 A2,616074.7006,201248.5564,1504.5308
R110 A1,616074.6902,201248.5538,1505.8290
R 100 A7,616090.3059,201233.4036,1515.2045
R 100 A6,616088.4793,201237.5139,1510.8940
R 100 A5,616088.5176,201238.6778,1509.0895
R 100 A4,616085.8643,201243.8167,1506.4532
R 100 A3,616086.1550,201245.0846,1504.5202
R 100 A2,616085.0844,201247.8733,1504.3970
R 100 A1,616084.3792,201250.8114,1504.4809
R 90 A6,616101.2998,201231.2315,1516.6469
```

**Figure 4.13** Terrain file

```
R 90 A5,616099.4120,201235.9200,1511.9203
R 90 A4,616099.9553,201237.4199,1508.8755
R 90 A3,616095.7704,201243.2195,1506.4878
R 90 A2,616094.5800,201251.5709,1504.0977
R 90 A1,616094.0316,201254.6649,1504.0855
R80 A7 ,616110.6784,201234.0207,1516.4486
R80 A6 ,616110.9556,201236.6374,1513.7961
R80 A5 ,616108.1733,201239.4192,1510.3085
R80 A4 ,616108.8124,201241.2646,1508.2837
R80 A3 ,616107.3190,201245.9363,1505.0276
R80 A2 ,616104.7799,201252.7682,1503.7359
R80 A1 ,616103.8592,201255.6504,1503.8123
A 5,616080.6607,201250.0927,1505.4687
R75 A7,616112.0708,201233.6544,1516.8489
R75 A6,616113.0395,201237.0976,1513.2599
R75 A5,616112.4561,201238.9856,1509.7547
R75 A4,616112.1319,201240.4912,1507.7911
R75 A3,616113.5836,201242.0196,1505.5208
R75 A2,616109.0642,201253.6000,1503.4912
R75 A1,616107.4796,201258.6222,1503.6624
R60 A8,616125.2678,201233.6751,1516.9087
R60 A7,616129.6286,201236.5713,1514.6153
R60 A6,616129.5837,201237.3791,1512.9620
R60 A5,616128.2140,201238.7101,1510.2252
R60 A4,616125.5106,201239.4776,1508.4877
R60 A3,616125.6039,201241.3783,1506.8608
R60 A2,616124.7137,201251.0169,1505.3879
R60 A1,616123.6117,201256.4916,1503.5414
R40 A8,616149.3382,201236.8522,1517.1411
R40 A7,616150.5767,201238.5590,1515.2903
R40 A6,616150.1518,201240.9505,1513.6093
R40 A5,616147.5763,201241.3000,1511.6999
R40 A4,616145.6326,201242.8721,1508.1251
R40 A3,616144.8723,201243.8527,1505.8809
R40 A2,616143.2242,201244.4860,1504.3624
R40 A1,616141.9901,201260.2282,1503.5196
R30 A9,616154.7842,201237.8848,1517.1402
R30 A8,616155.4843,201239.4825,1514.8736
R30 A7,616155.5834,201242.8579,1511.7912
R30 A6,616154.0034,201242.5079,1509.5564
R30 A5,616154.1175,201244.3643,1506.6119
R30 A4,616154.1146,201246.4754,1503.3092
R30 A3,616154.1507,201250.7614,1503.2716
R30 A2,616153.4397,201256.7991,1503.5344
R30 A1,616152.0353,201262.3983,1503.5626
R20 A10,616167.2893,201240.0501,1517.4370
R20 A9,616167.8689,201241.4365,1515.0103
R20 A8,616167.2294,201242.2283,1513.6069
R20 A7,616166.3719,201242.8251,1511.8478
R20 A6,616169.2562,201249.2073,1508.6589
R20 A5,616166.5030,201248.5284,1505.6906
R20 A4,616165.4657,201251.6739,1505.1097
R20 A3,616164.1096,201255.5514,1503.9035
```

**Figure 4.14** Terrain file

```
R20 A2,616162.9186,201260.4428,1503.7291
R20 A1,616162.0283,201264.6163,1503.4395
R10 A10,616175.1822,201241.5521,1517.8837
R10 A9,616175.2320,201241.9020,1516.5056
R10 A8,616175.6211,201244.7205,1514.1157
R10 A7,616174.8654,201245.8619,1511.5759
R10 A6,616174.8226,201245.6312,1510.1185
R10 A5,616174.4775,201249.8940,1506.1396
R10 A4,616173.8626,201252.2041,1504.3219
R10 A3,616173.3158,201256.5283,1503.4198
R10 A2,616172.4441,201261.7783,1503.5840
R10 A1,616172.0366,201266.4943,1503.3865
R-30 A10,616206.9047,201252.7234,1519.8244
R-30 A9,616207.1428,201253.6739,1517.2321
R-30 A8,616209.9654,201253.0142,1518.0235
R-30 A7,616212.2219,201255.1849,1514.8857
R-30 A6,616211.2051,201257.8380,1511.7894
R-30 A5,616212.6819,201260.7882,1509.7449
R-30 A4,616212.7230,201262.6970,1508.2362
R-30 A3,616213.9438,201265.6367,1506.6700
R-30 A2,616213.3260,201270.4688,1505.2833
R-30 A1,616213.0043,201275.2660,1504.5922
R-18 A9,616203.8247,201252.1127,1519.7827
R-18 A8,616203.2480,201252.5102,1517.6156
R-18 A7,616202.6474,201254.7068,1514.6604
R-18 A6,616202.8007,201256.2418,1511.5188
R-18 A5,616202.8792,201257.6672,1509.2196
R-18 A4,616202.4985,201259.1963,1506.8023
R-18 A3,616202.0337,201262.0428,1505.7646
R-18 A2,616201.7237,201266.2313,1504.5072
R-18 A1,616200.4892,201272.1827,1503.3272
R-10 A10,616198.7581,201250.5300,1519.5719
R-10 A9,616198.9227,201251.1478,1517.6554
R-10 A8,616198.4674,201252.1637,1516.2186
R-10 A7,616197.6624,201254.0062,1512.9202
R-10 A6,616197.4196,201254.9477,1510.5905
R-10 A5,616196.3303,201256.9751,1507.1887
R-10 A4,616195.3180,201259.8036,1506.2302
R-10 A3,616193.9613,201263.2993,1505.3896
R-10 A2,616192.8901,201267.5328,1503.8470
R-10 A1,616192.0042,201270.4761,1503.5617
```

**Figure 4.15** Terrain file

This is terrain file which import from Create Terrain Model from ASCII File.

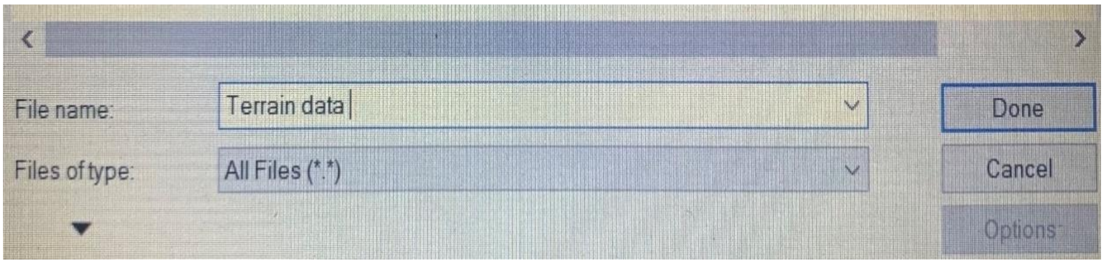



**Figure 4.16** Working Window

Now set all the data from here which want should be in 2D sheet file.

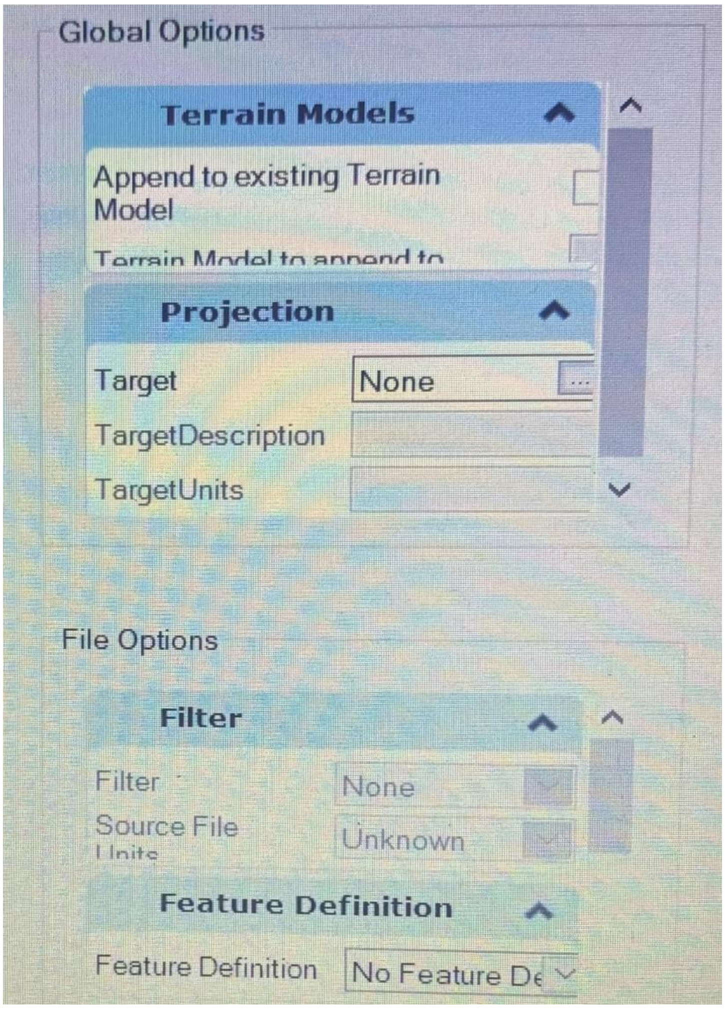



**Figure 4.17** Working Window

From Feature Definition select the data which has to be import.

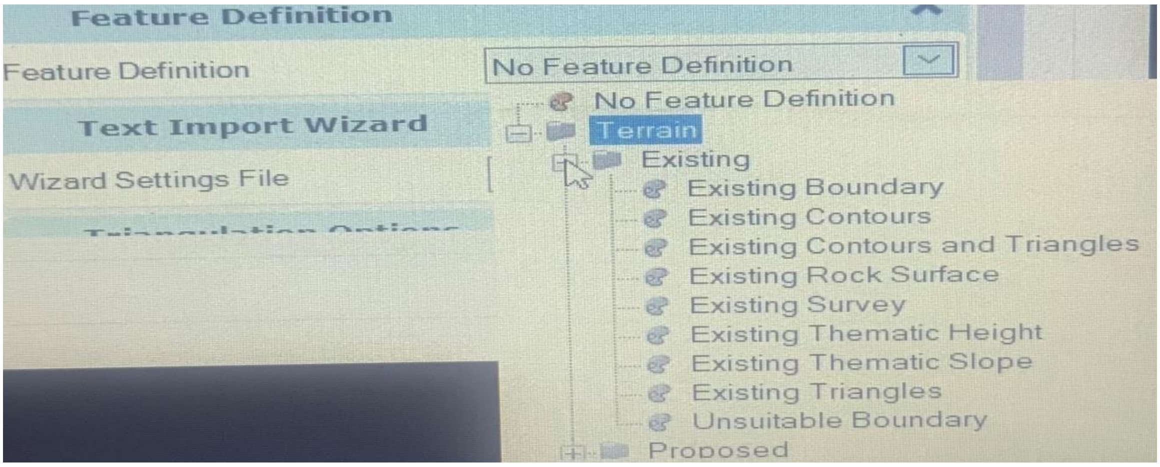



**Figure 4.18** Working Window

Here only export Existing Boundary of our terrain

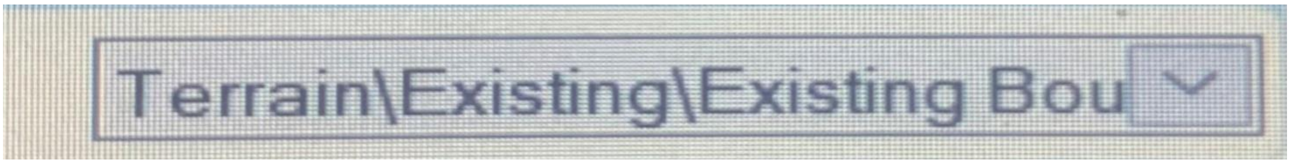



**Figure 4.19**Working Window

Terrain file in 2D sheet file with Existing Boundary of the terrain file.

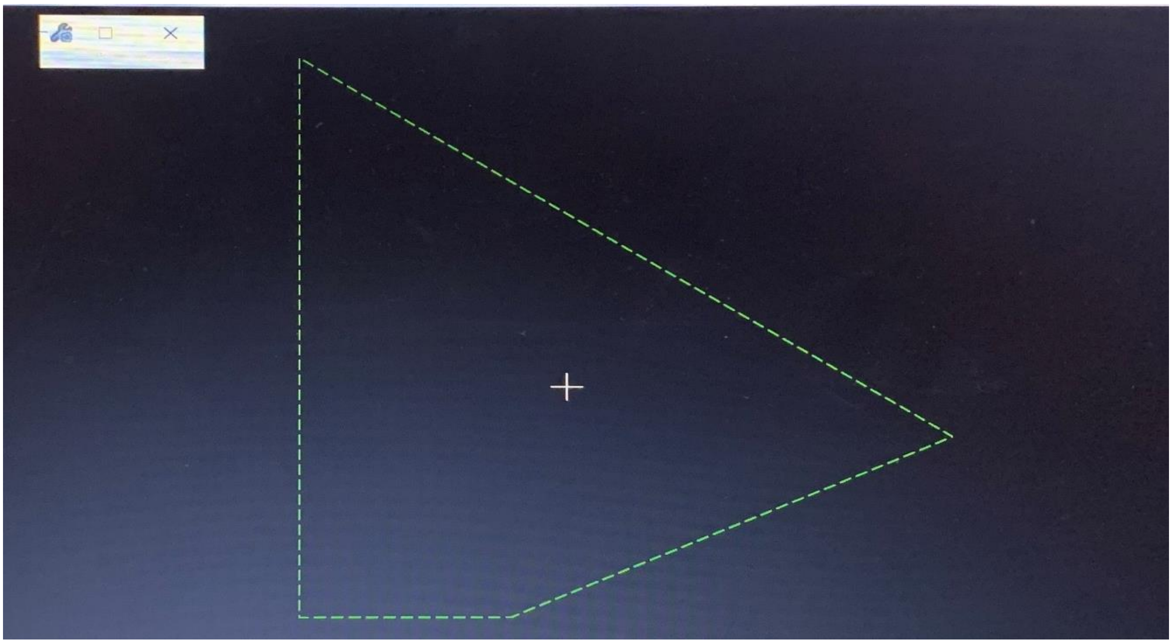


**Figure 4.20** Working Window

## 4.3 SI UNITS AND OTHER STANDARD VALUES

From Design File Setting set all the values.

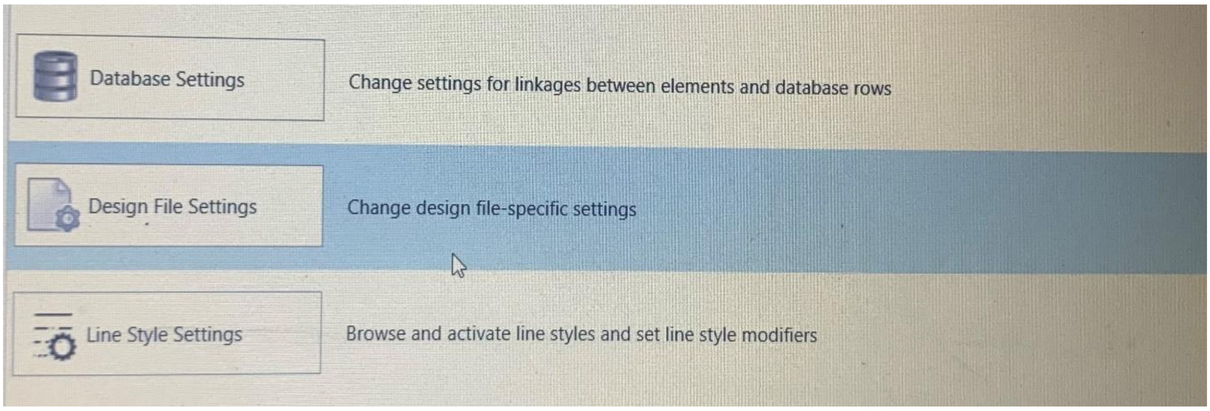



**Figure 4.21** Working Window

These are the linear units which is set for our design work

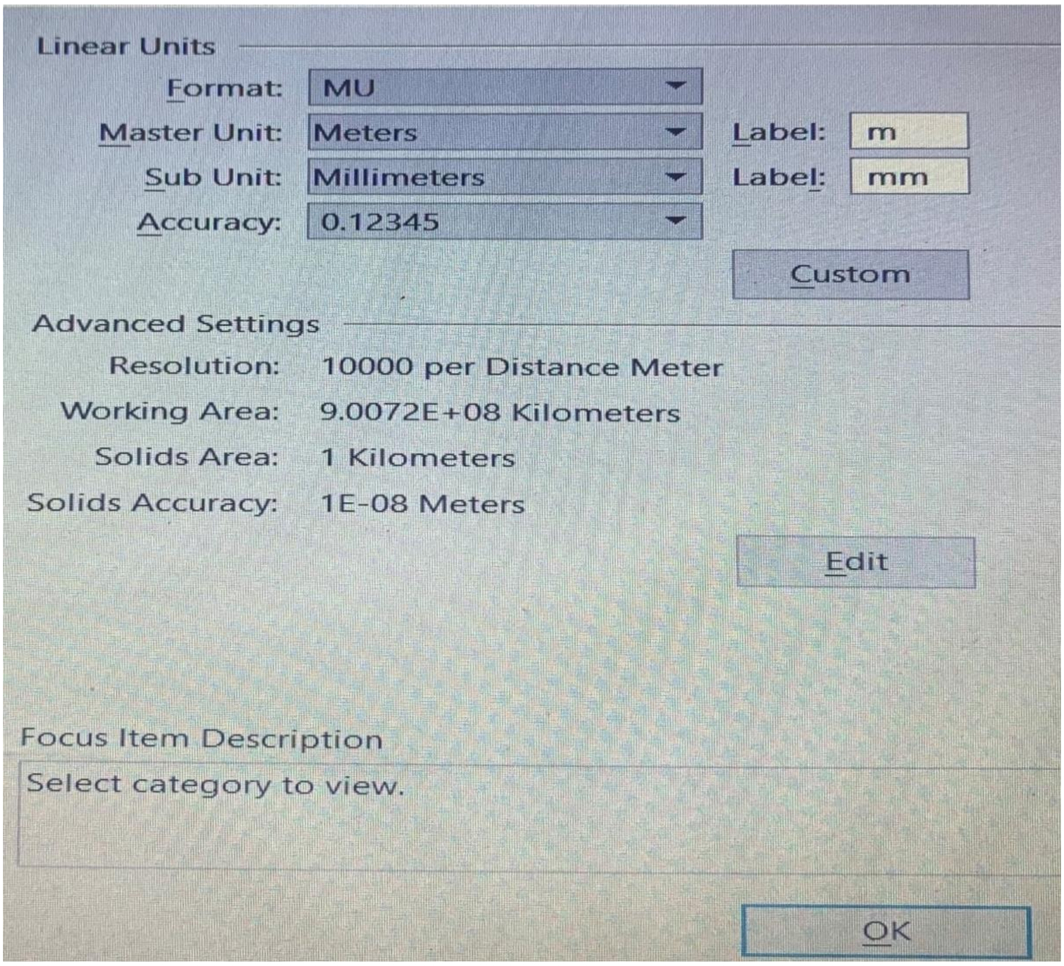



**Figure 4.22** Working Window

These are the Civil Format setting for our work

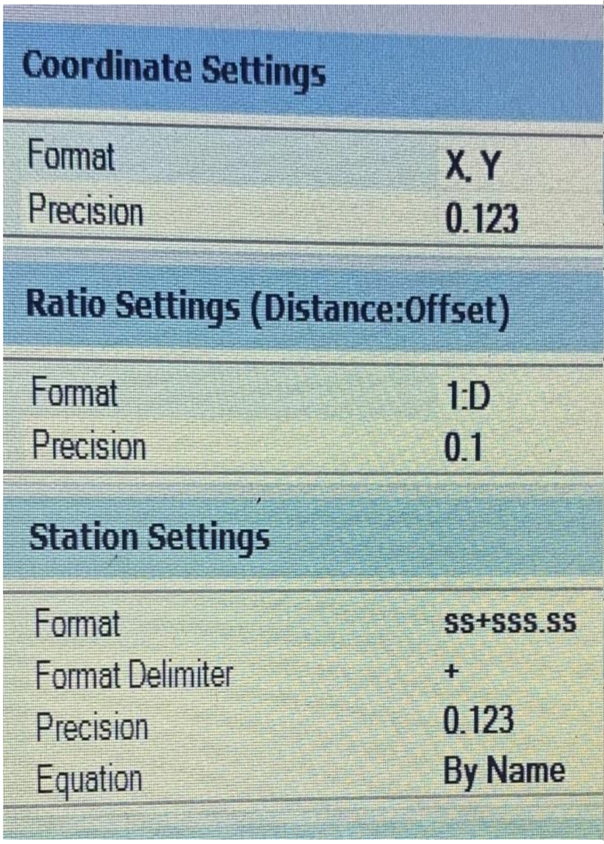



**Figure 4.23** Working Window

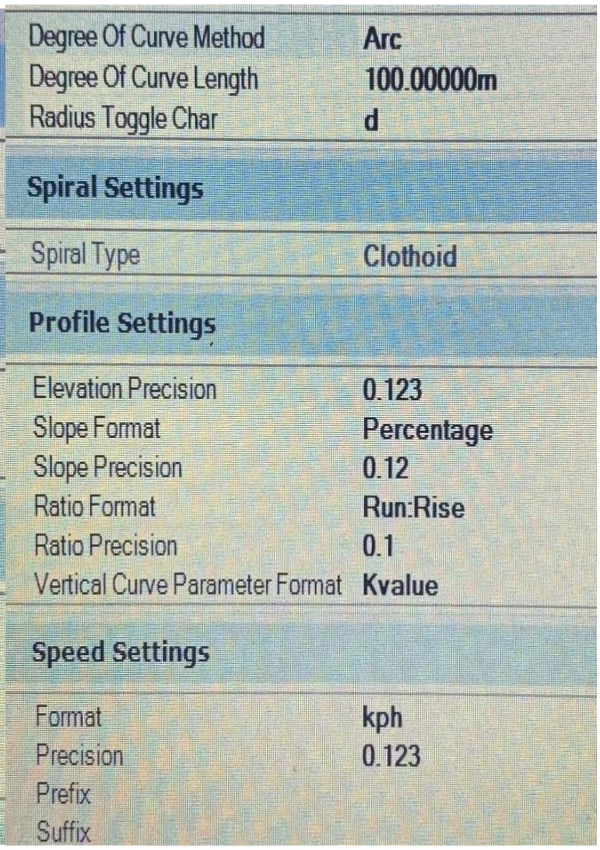



**Figure 4.24** Working Window

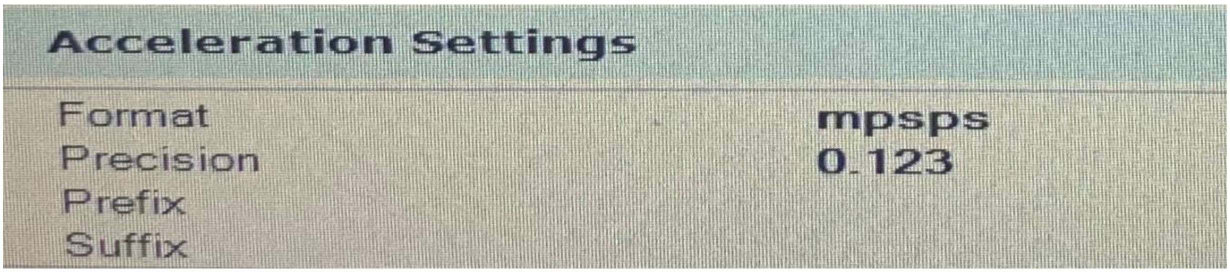



**Figure 4.25** Working Window

Now set the scale for work.

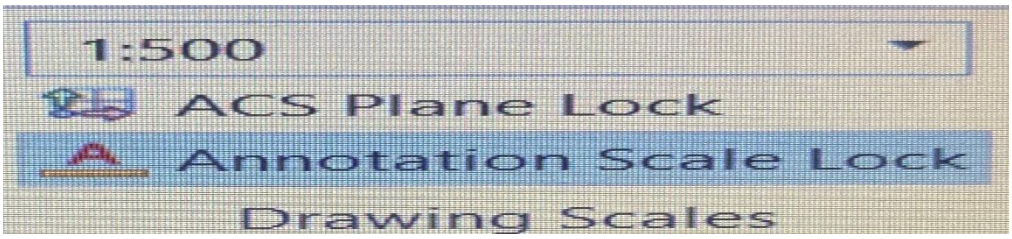



**Figure 4.26** Working Window

## 4.4 ANALYSIS OF TERRAIN

In analysis of terrain here fully analysis of terrain is done will analyse all the contours, find area of terrain, see this terrain in colour codes and also find out slope and distance between different points in terrain.

There is different options

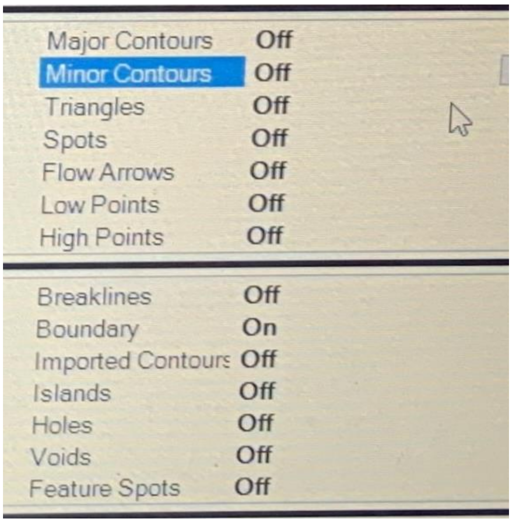



**Figure 4.27** Working Window

Now these are the contour lines of this terrain.

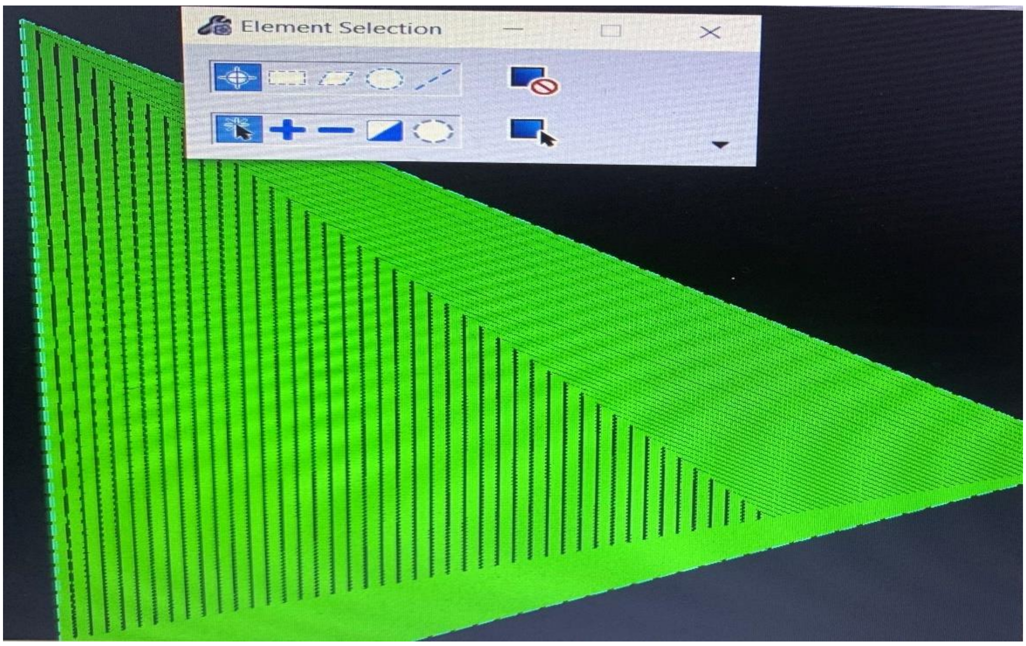



**Figure 4.28** Result (Contour lines)

Contour lines are the lines which joins different points of same elevation or same height.

From these figures anyone can analyse these all line which are continuous have same elevation or height but the different lines have different elevations.

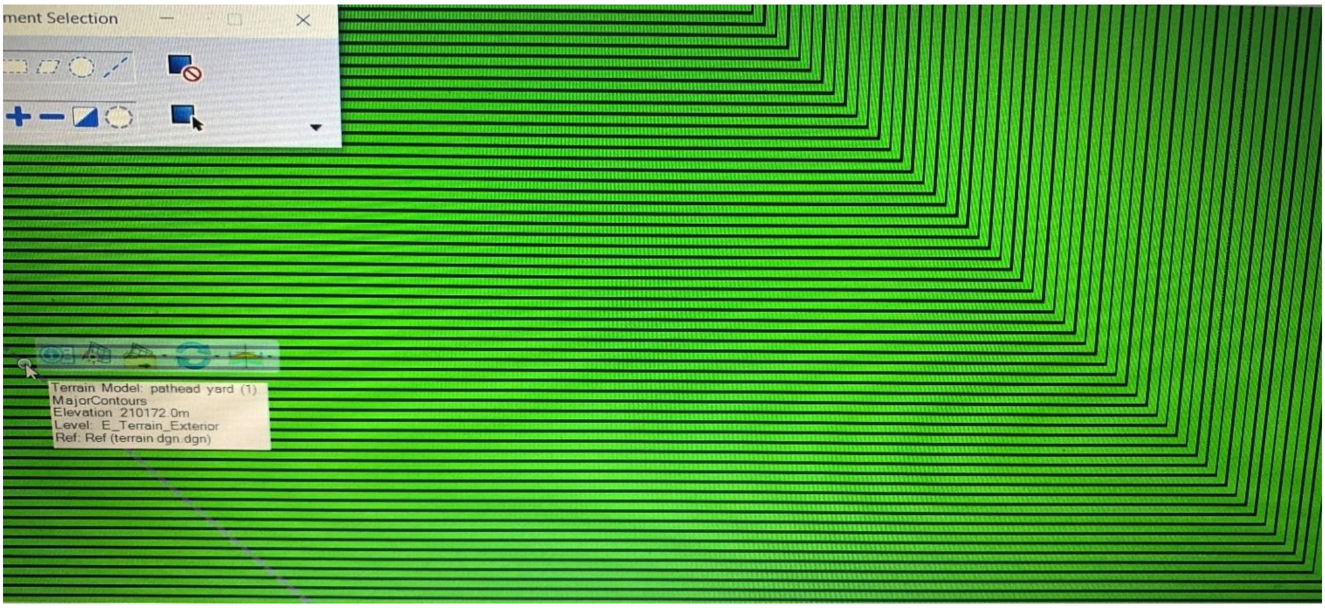



**Figure 4.29** Result (Contour lines)

Now there find the area of this terrain.

Before finding area of terrain Triangulation is done.

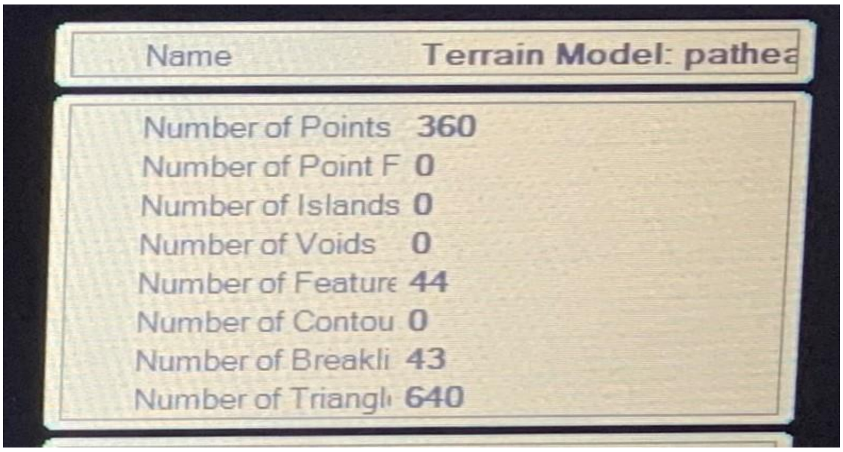



**Figure 4.30** Working Window

Here the total number of Triangles are 640

The principle of area calculation;

1) Work from whole to part.
2) Divide the area into the triangles then our errors get reduce.

Now the area of this terrain is

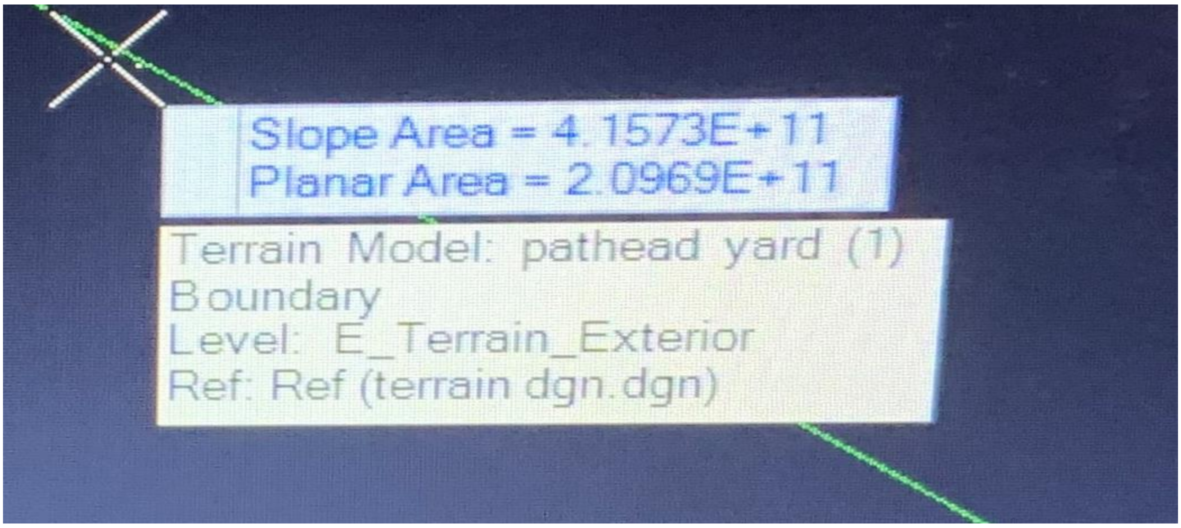



**Figure 4.31** Result (Area of Terrain)

This area is in m2 because in starting design standard units as meter.

From this result can analyse how big is this terrain.

Now there find out the distance and elevation between any two parts.

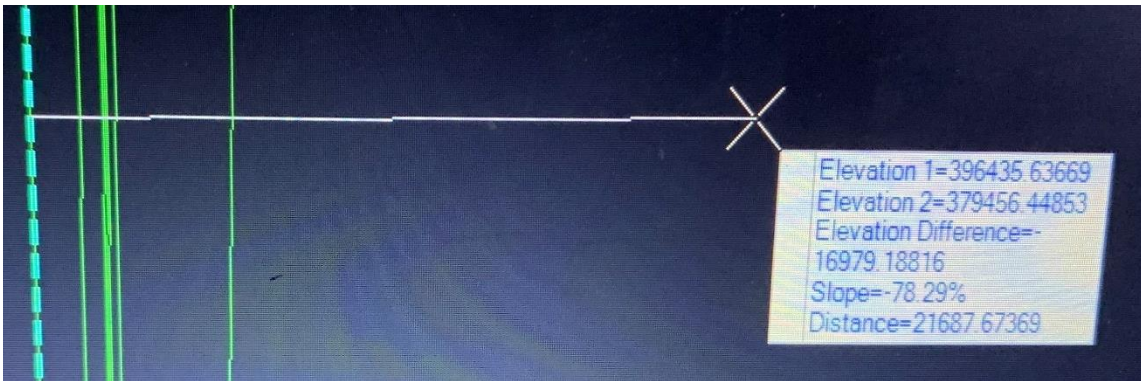



**Figure 4.32** Working Window

There is slope and distance between the two points of terrain.

Now there analyse the terrain in 2 different display styles.

Thermal Slope.

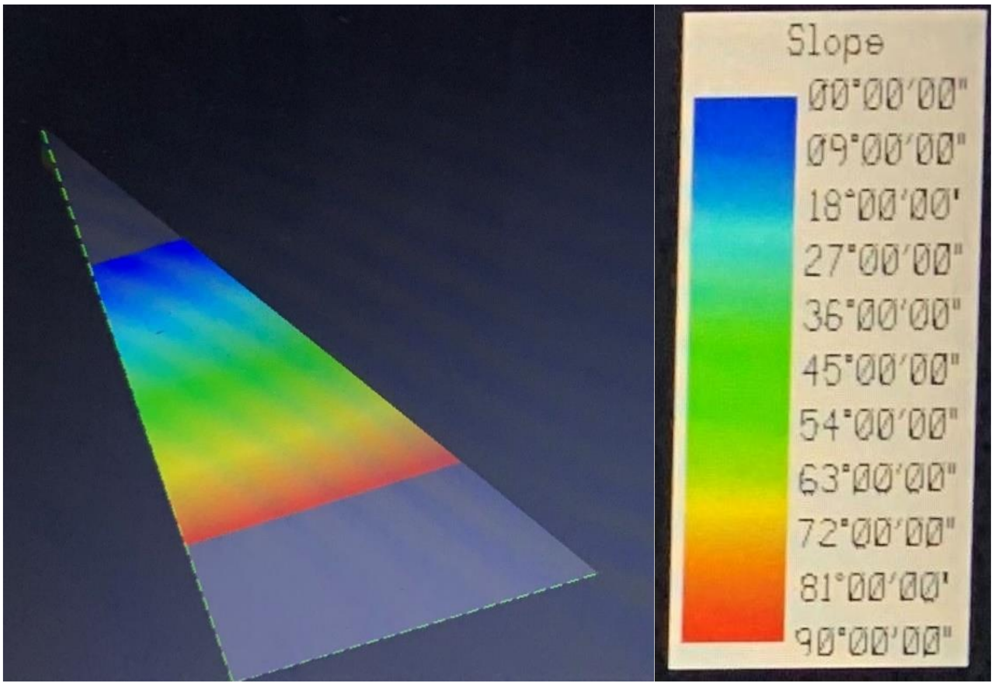



**Figure 4.33** Result (Slope of Terrain)

Thermal Height

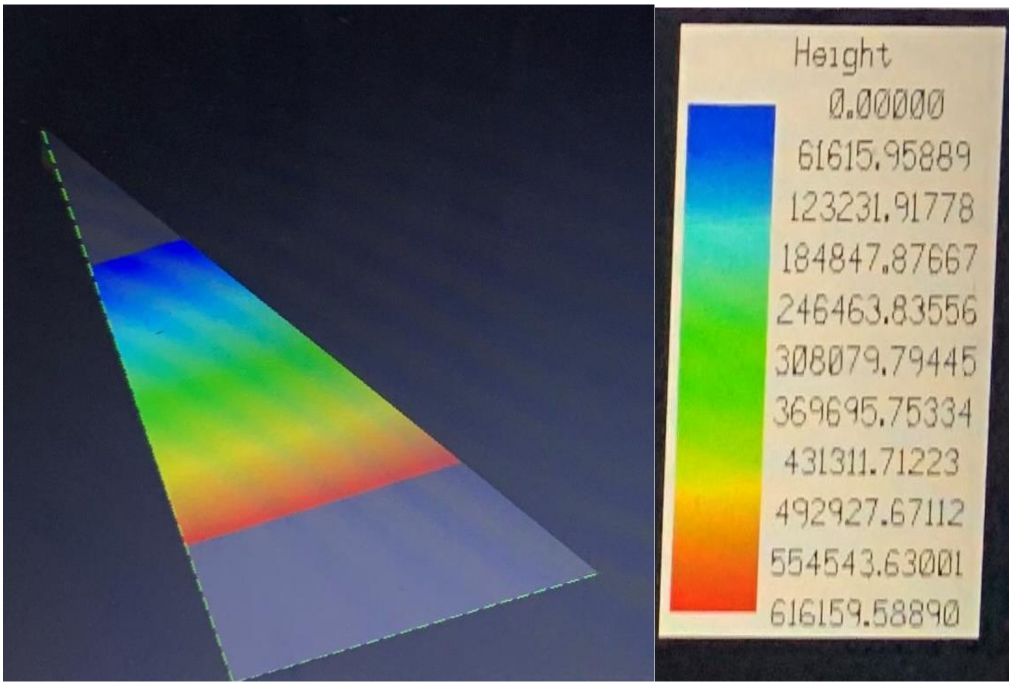



**Figure 4.34** Result (Slope of Terrain)

## 4.5 DESIGN OF RIGID PAVEMENT

Design part will be done on 3D file. So, now open 3D sheet file and design our pavement.

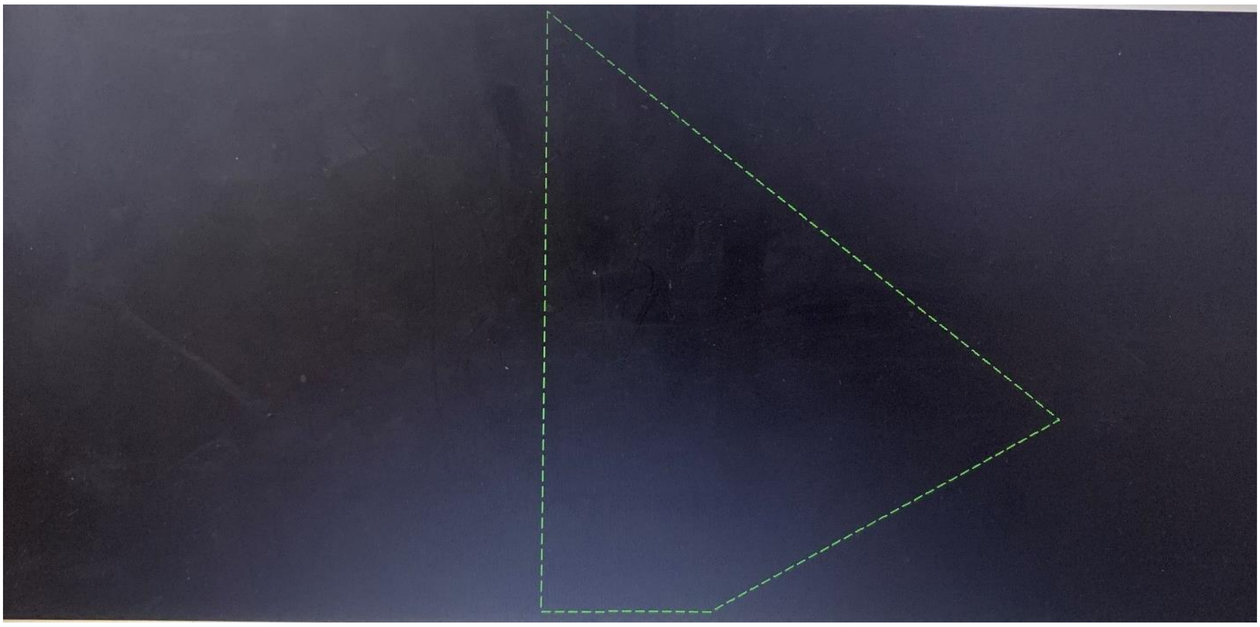


**Figure 4.35** Working Window

First design the basic alignment of the pavement.

Between these two white marks design of pavement has to be done.

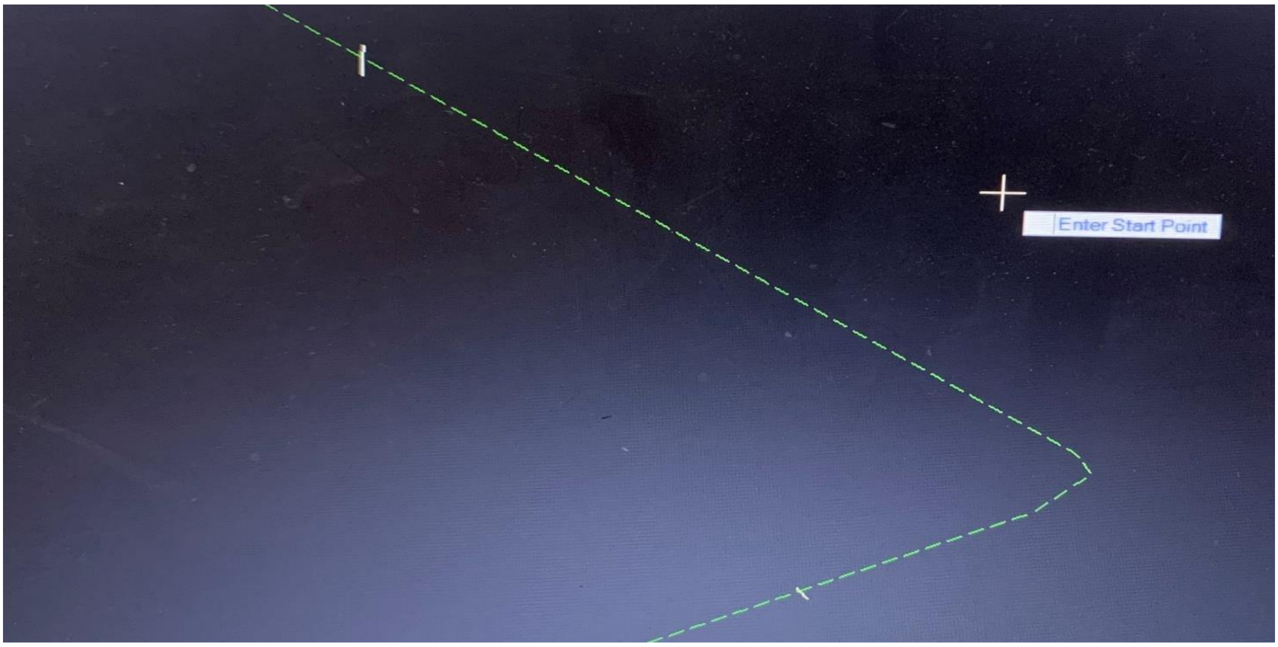



**Figure 4.36** Working Window

Design of basic alignment

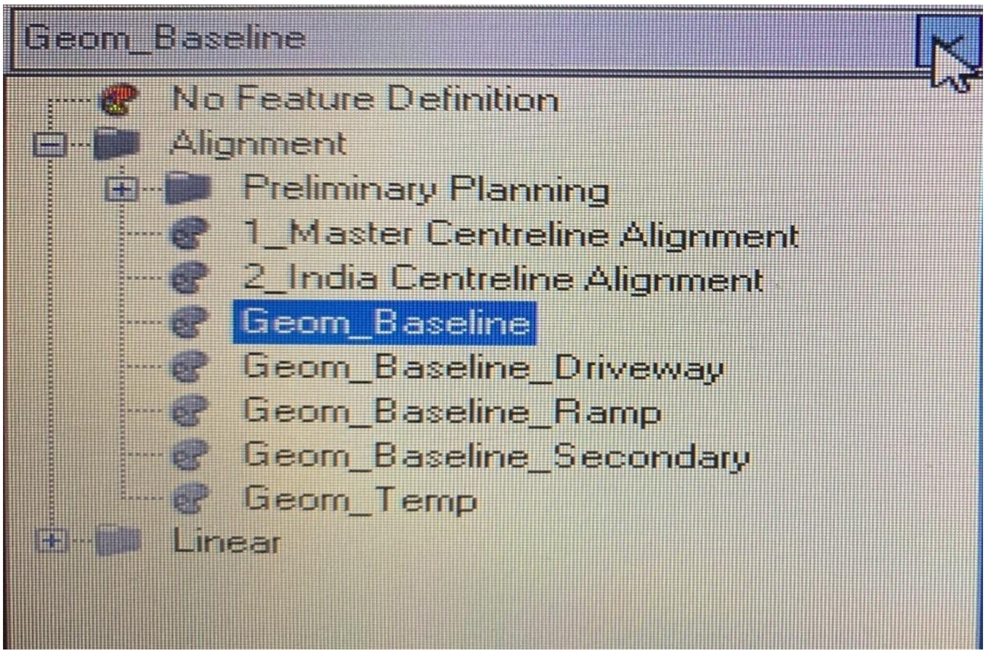



**Figure 4.37** Working Window

Now start design

Here from starting point to end point provide 3 Curves and total length of pavement is 4.845 KM or 4845 M

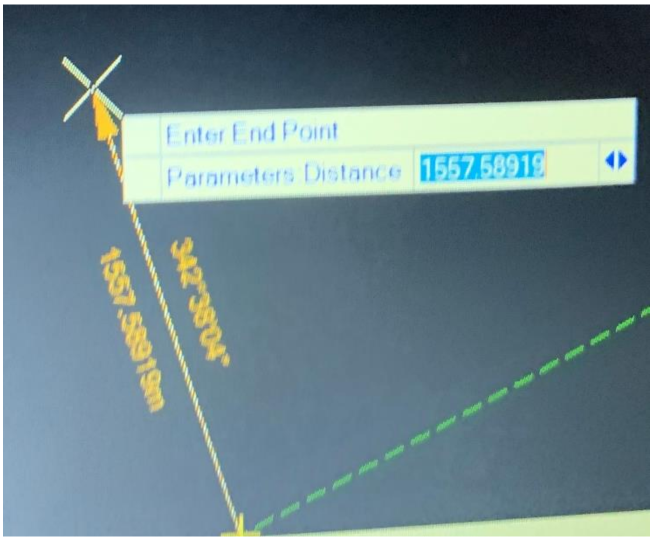



**Figure 4.38** Working Window

Here provide 1st length of 1557.5 M or 1.5 KM (this is a straight path)

After this from the end point of this provide next length.

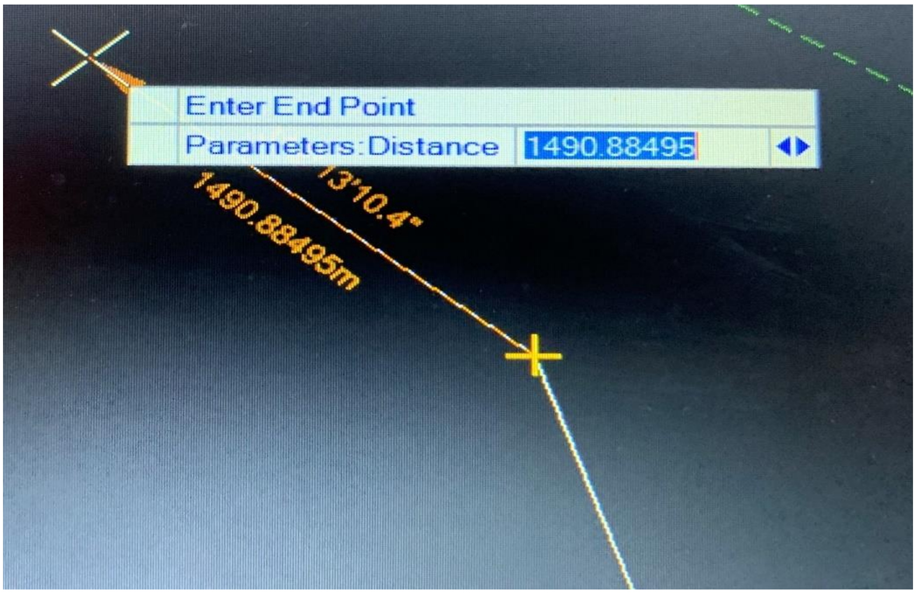



**Figure 4.39** Working Window

The length of this span is 1.490 KM or 1490 M

From the same point provide next length.

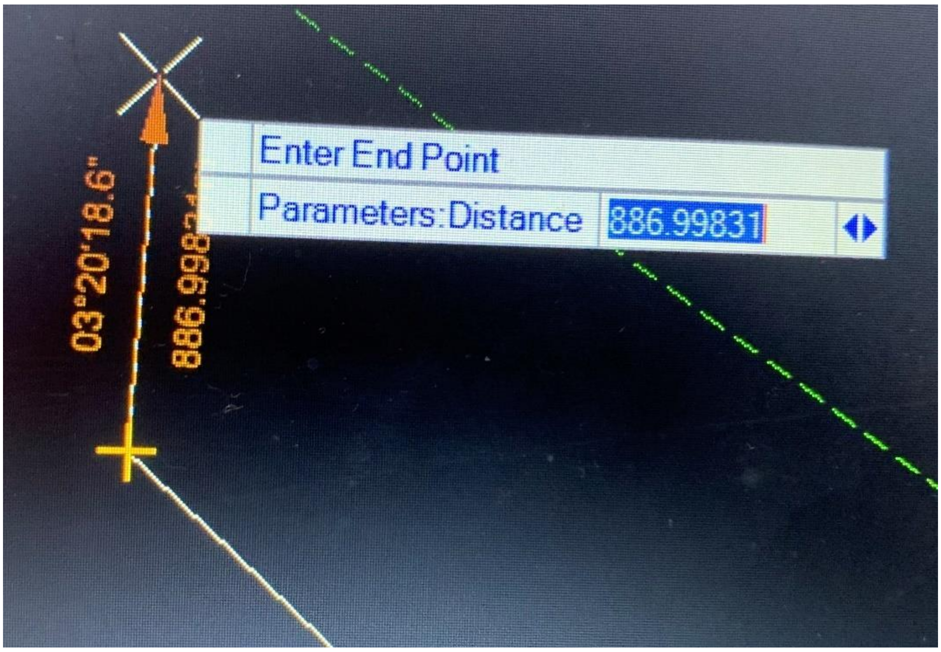



**Figure 4.40** Working Window

The length of this one is 0.88 KM or 886.9 M.

Now from the same point provide last span of our alignment.

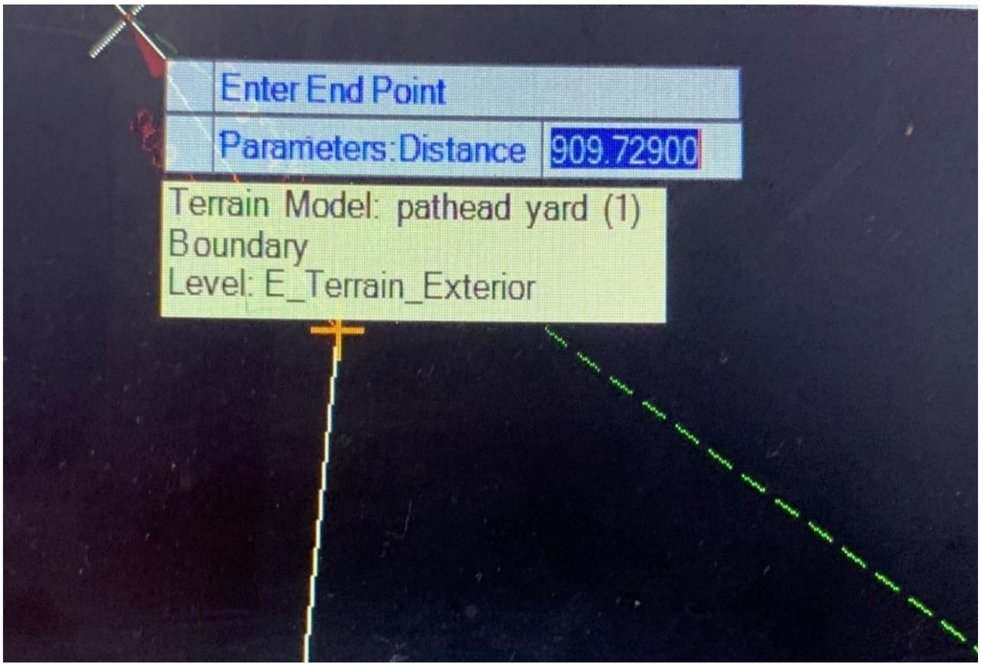



**Figure 4.41** Working Window

And the length of this last part is 0.9 KM or 909.72 M.

Now this is the alignment of pavement with edges (without curves) with total length of 4.845 KM

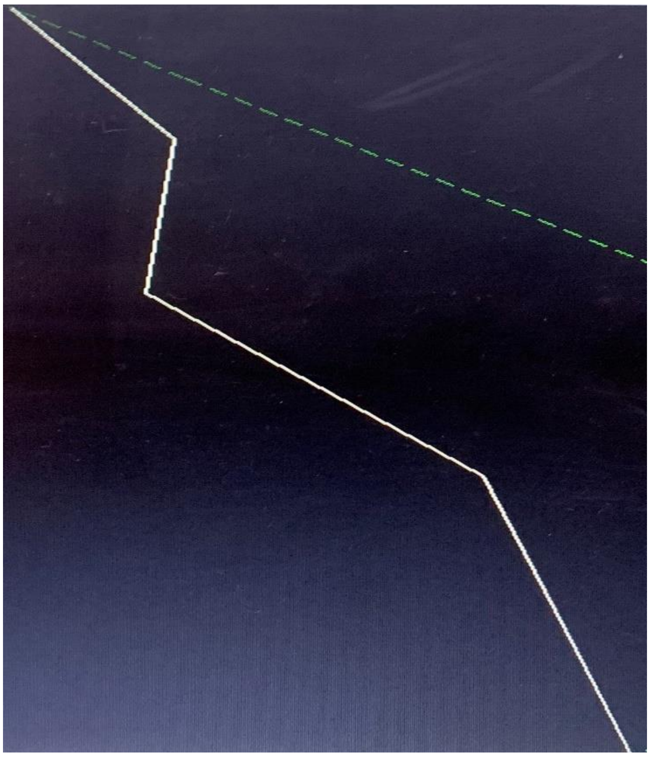


**Figure 4.42** Working Window

Now there provide curves to create smooth alignment. For the comfort of driver, passenger, causes less wear and tear to the vehicle and safety of the road users.

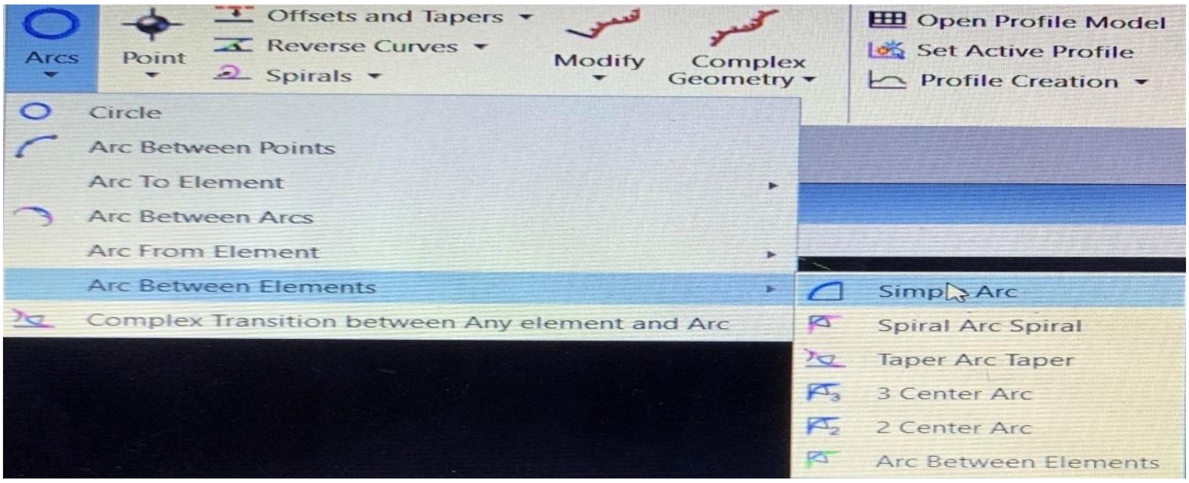
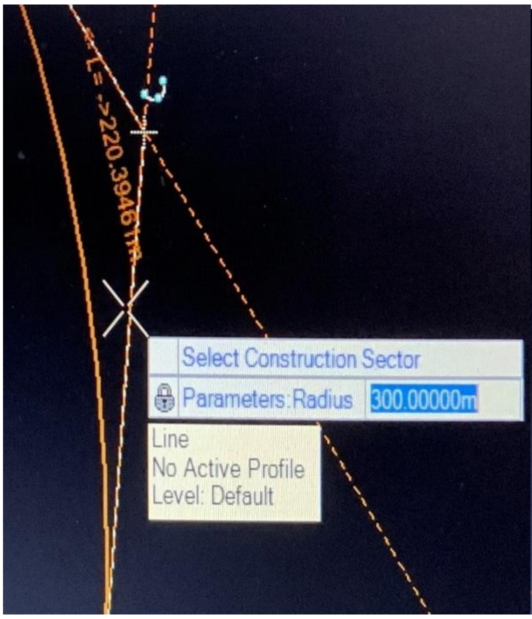



**Figure 4.43** Working Window

By using these commands provide radius at curves.

Now here provide radius 300 meter to each curve. If this radius is not safe for this pavement in check part software will give error.



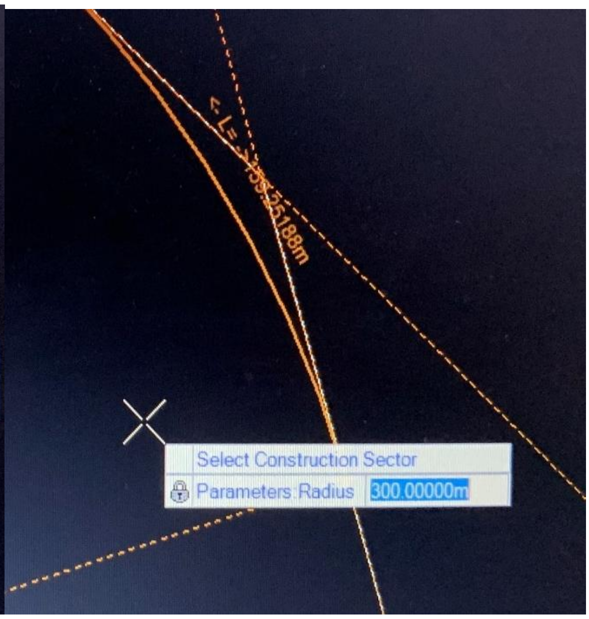




**Figure 4.44** Working Window

**Figure 4.45** Working Window

In this way on each turn of a curve provide a radius of 300 meter.

Now this is our basic alignment of pavement with curves each of radius 300 meter.

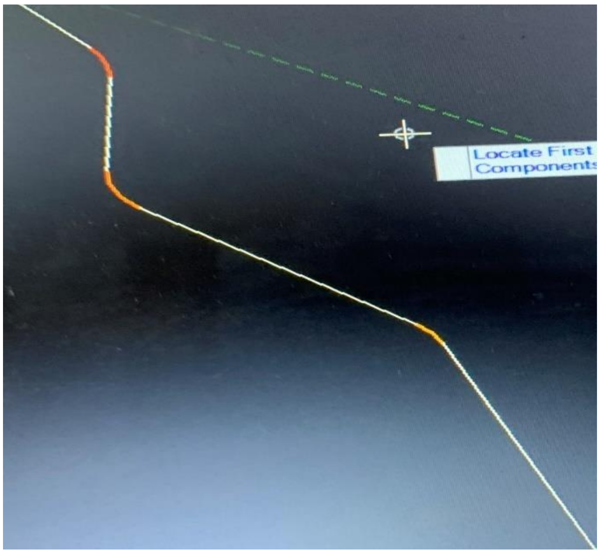



**Figure 4.46** Working Window

Now this section of road has different elements from there convert this all elements into one part or in different number of parts.

As in this fig 4.44 we have 7 elements 3 curves and 4 lines.

For converting this there is two method in complex geometry.

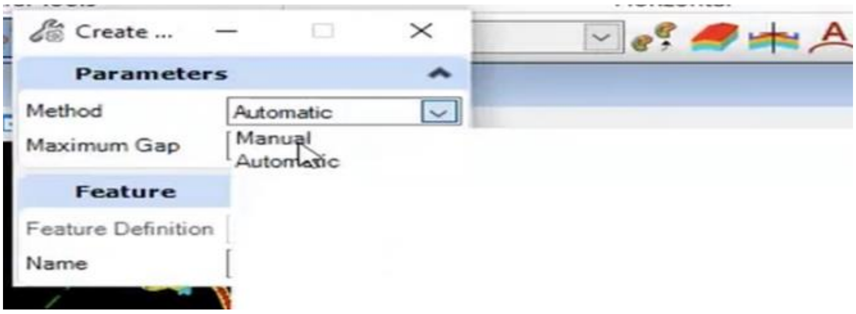



**Figure 4.47** Working Window

Two methods

- Automatic method.
- Manual method.

In automatic method the whole pavement is converted in one element. Only select one part of pavement and whole pavement will convert into one element.

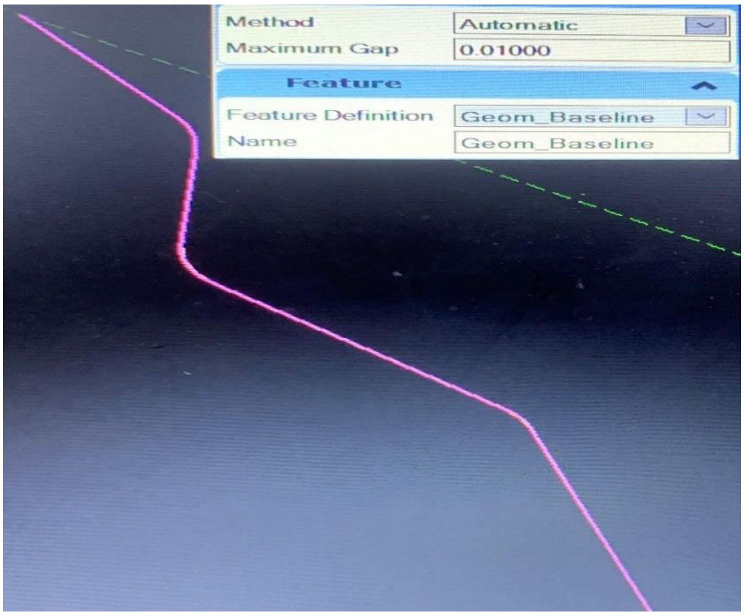
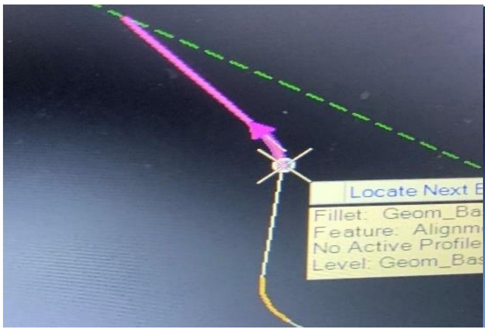



**Figure 4.48** Working Window

Now this whole alignment is converted in one element. (this is done by automatic method)

Now in manual method there is option to convert pavement into one or different number of elements by selecting each part one by one.



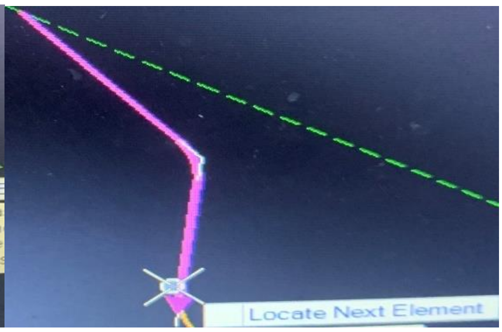




**Figure 4.49**Working Window **Figure 4.50**Working Window

In case of manual the alignment can be converted into one or small different elements. So,in case of manual it is possible to give different commands to the different elements ( If anyone want this road starting part should be bitumen pavement and other will be concrete so can select first part and give command of bitumen and then other part of concrete but in case of automatic this is not possible in that case whole pavement should be of bitumen or concrete.)

But in this project automatic method and the final design of alignment is given below.

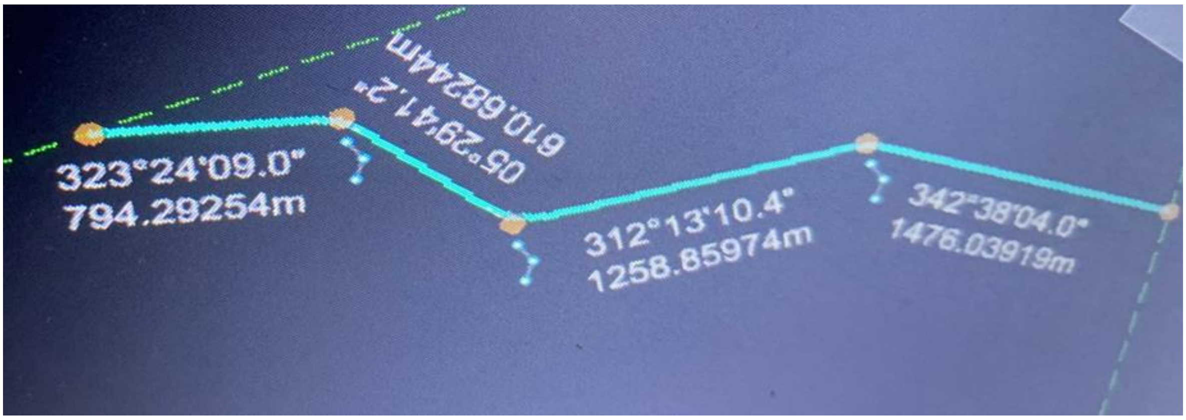
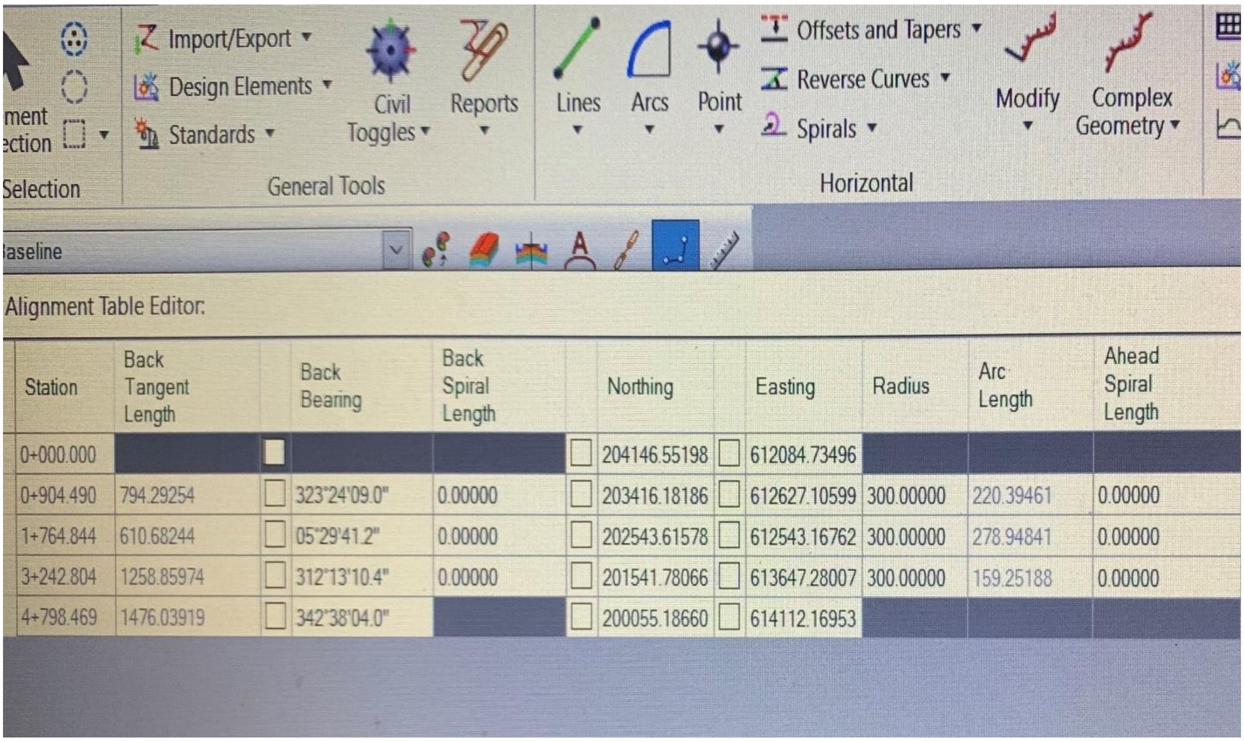



**Figure 4.51** Result (Alignment of the Pavement)

Now there is Table editor report of this alignment.




| Station | Back Tangent Length | Back Bearing | Back Spiral Length | Northing | Easting | Radius | Arc Length | Ahead Spiral Length |
|---|---|---|---|---|---|---|---|---|
| 0+000.000 | | | | 204146.55198 | 612084.73496 | | | |
| 0+904.490 | 794.29254 | 323°24'09.0" | 0.00000 | 203416.18186 | 612627.10599 | 300.00000 | 220.39461 | 0.00000 |
| 1+764.844 | 610.68244 | 05°29'41.2" | 0.00000 | 202543.61578 | 612543.16762 | 300.00000 | 278.94841 | 0.00000 |
| 3+242.804 | 1258.85974 | 312°13'10.4" | 0.00000 | 201541.78066 | 613647.28007 | 300.00000 | 159.25188 | 0.00000 |
| 4+798.469 | 1476.03919 | 342°38'04.0" | | 200055.18660 | 614112.16953 | | | |

**Figure 4.52** Result (Table Editor Report of Alignment)

Apply design values on this alignment.

**Figure 4.53** Working Window

From here apply design speed values for the give alignment. This is American based software so it will show values according to their codes.


**Figure 4.54** Working Window

These are the values according to UK design but IRC are installed so it also show IRC design library.


**Figure 4.55** Working Window

Now from here select first the type of terrain on which the design of pavement part is done and then the number of lanes for pavement.

As the terrain is Mountainous And Steep Terrain and this pavement design is for 2 Lane pavement.

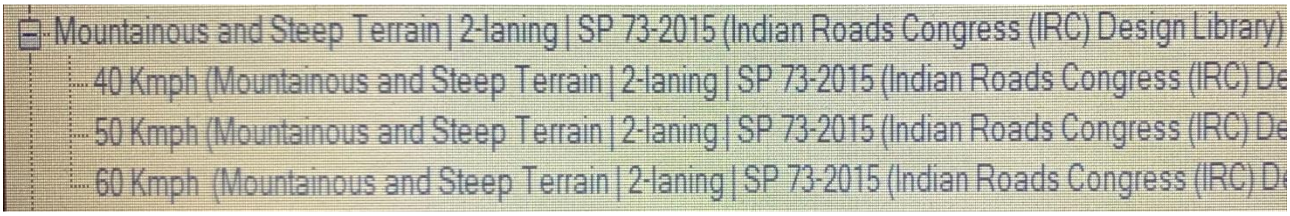



**Figure 4.56** Working Window

From here select the design speed for pavement.

From this library select design speed as 60 KMPH for 2 lane pavement on Mountainous and steep terrain.

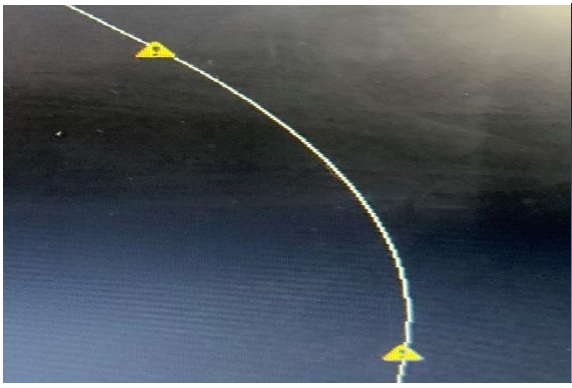


**Figure 4.57**Working Window

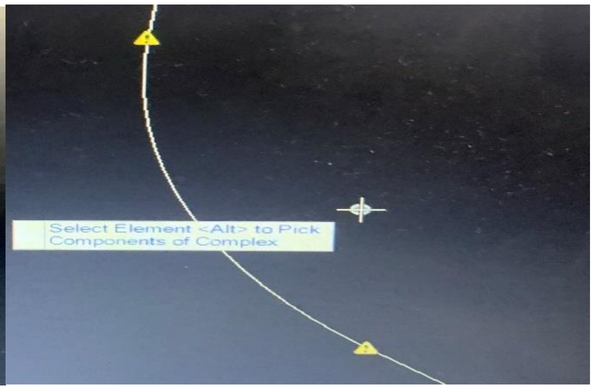



**Figure 4.58**Working Window

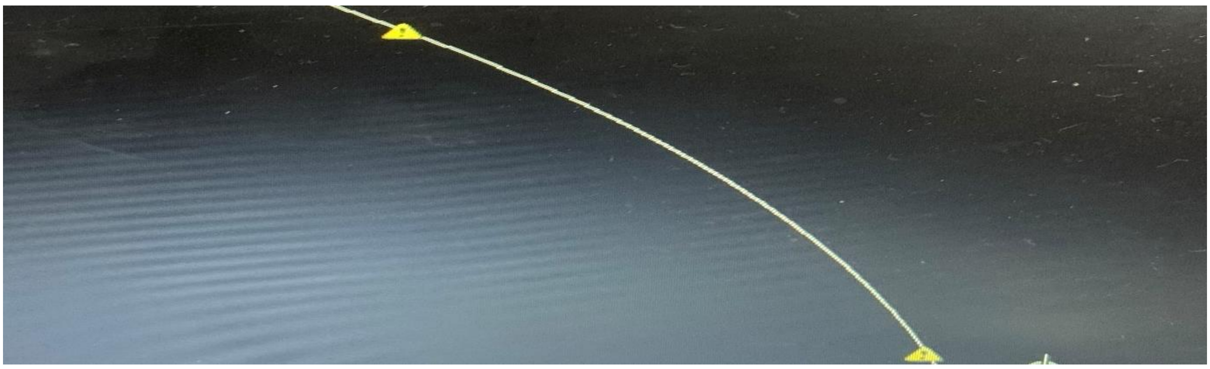


**Figure 4.59**Working Window

These are the curves of pavement at 60 KMPH speed as there it is not showing any error but it is showing sign of danger that this road is not safe for speed more than 60 KMPH but now for 60 KMPH this is safe design.

Now just for check apply design speed as 100 KMPH.(is this safe for our design)

Results on 100 KMH speed.

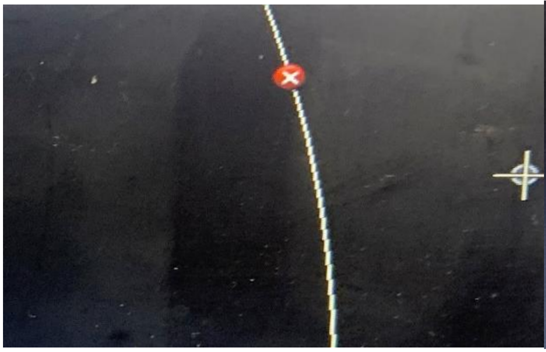


**Figure 4.60** Working Window

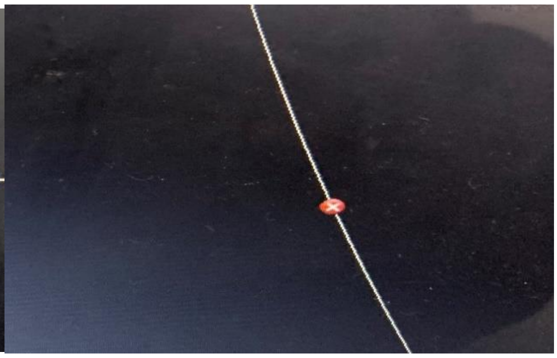


**Figure 4.61** Working Window

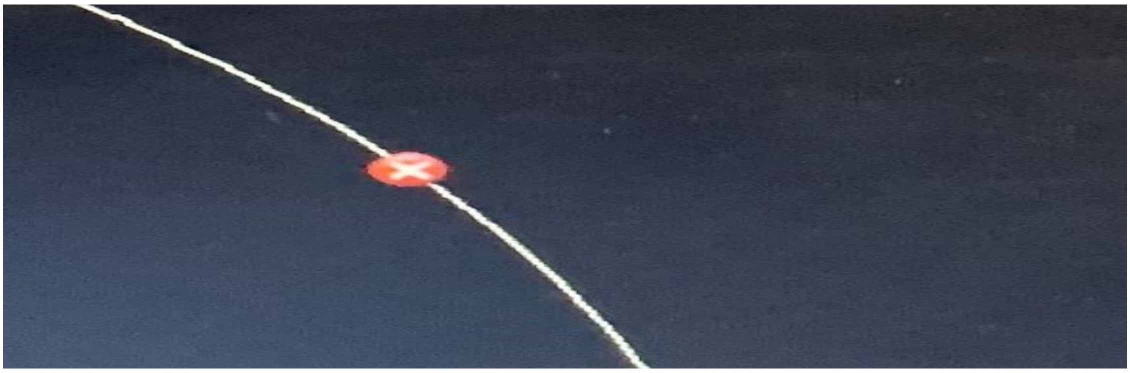


**Figure 4.62** Working Window

For 100 KMPH. It is showing error on each curve. So, this alignment is not safe for 100 KMPH. (there is the reasons for errors)

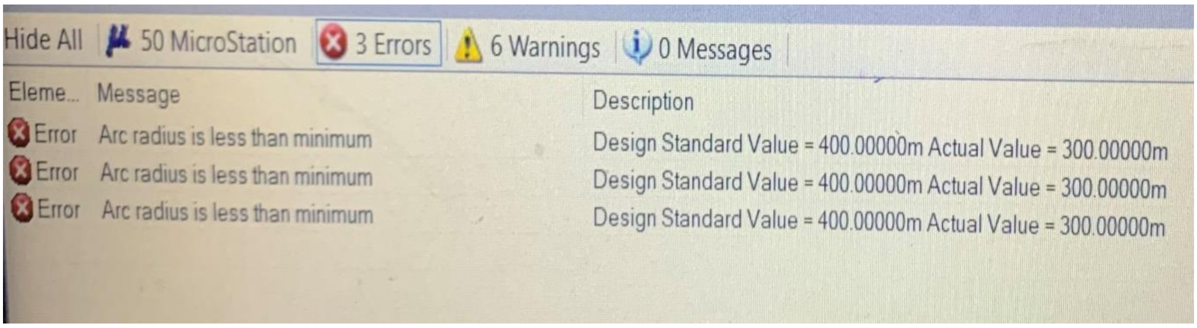



**Figure 4.63** Working Window

The reason for errors is Actual radius of curves is less then minimum radius suggested by IRC.

From table editor report also we can remove errors.

| Back Tangent Length | Back Bearing | Back Spiral Length | Northing | Easting | Radius | Arc Length | Design Speed | Ahead Spiral Length |
|---|---|---|---|---|---|---|---|---|
| | | | 204146.55198 | 612084.73496 | | | | |
| 794.29254 | 323°24'09.0" | 0.00000 | 203416.18186 | 612627.10599 | 300.00000 | 220.39461 | 100.00000 | 0.00000 |
| 610.68244 | 05°29'41.2" | 0.00000 | 202543.61578 | 612543.16762 | 300.00000 | Arc radius is less than minimum | | 00 |
| 1258.85974 | 312°13'10.4" | 0.00000 | 201541.78066 | 613647.28007 | 300.00000 | Design Standard Value = 400.00000 | | 00 |
| 1476.03919 | 342°38'04.0" | | 200055.18660 | 614112.16953 | | | | |

**Figure 4.64**Working Window

Edit these error values here in table editor report and apply it on alignment.

| Back Tangent Length | Back Bearing | Back Spiral Length | Northing | Easting | Radius | Arc Length | Design Speed | Ahead Spiral Length |
|---|---|---|---|---|---|---|---|---|
| | | | 204146.55198 | 612084.73496 | | | | |
| 755.81372 | 323°24'09.0" | 0.00000 | 203416.18186 | 612627.10599 | 400.00000 | 293.85948 | 100.00000 | 0.00000 |
| 572.20362 | 05°29'41.2" | 0.00000 | 202543.61578 | 612543.16762 | 300.00000 | 278.94841 | 100.00000 | 0.00000 |
| 1258.85974 | 312°13'10.4" | 0.00000 | 201541.78066 | 613647.28007 | 300.00000 | 159.25188 | 100.00000 | 0.00000 |
| 1476.03919 | 342°38'04.0" | | 200055.18660 | 614112.16953 | | | | |

**Figure 4.65**Working Window

In this way all these errors are removed but in this design apply design speed as 60 KMPH speed because here in this project connecting road is designed and for connecting road in hilly terrain this speed is satisfying.

At the point when the speed is expanded the from 60 KMPH to 100 KMPH the span of bend is additionally expanded by 100 meters on each bend. In complete arrangement there is 3 bends in each bend range is expanded by 100meters. So, for 100 KMPH extra length of 300 meters id required. It means as the design speed is increased the construction cost will also increases (labour cost, extra construction cost, extra land needed, time of construction increased) or limit the speed value.

Now the vertical geometry of pavement.

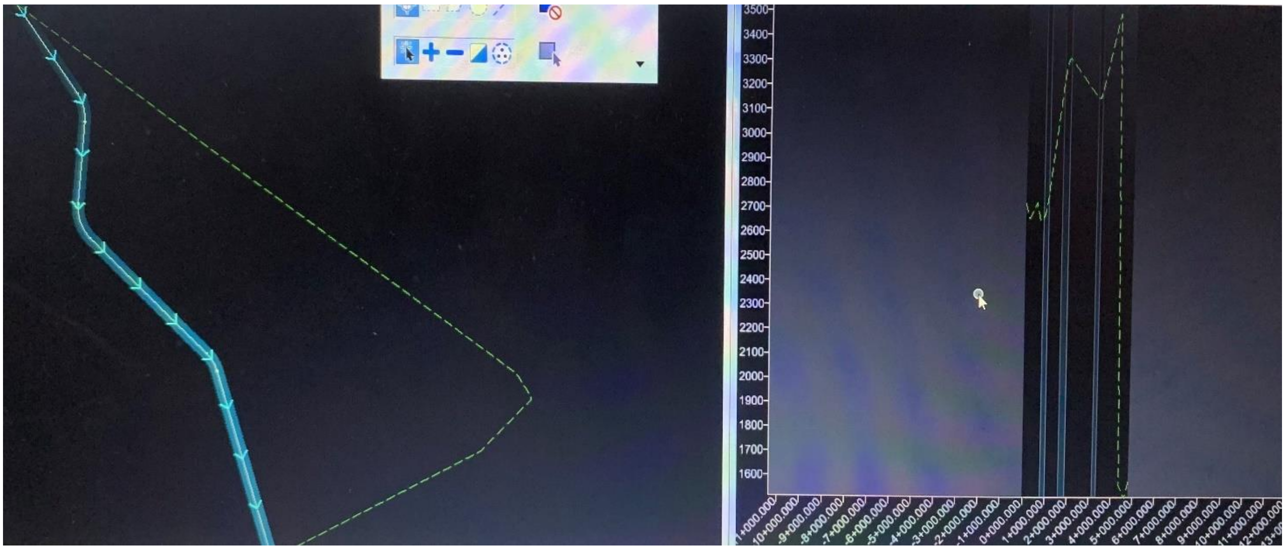


**Figure 4.66**Working Window

View 2 in fig 4.58 is the profile of the land under the pavement or the side view of the area which is under the pavement. (how much uneven it is)

Now in this vertical profile provide slope to the vertical part.

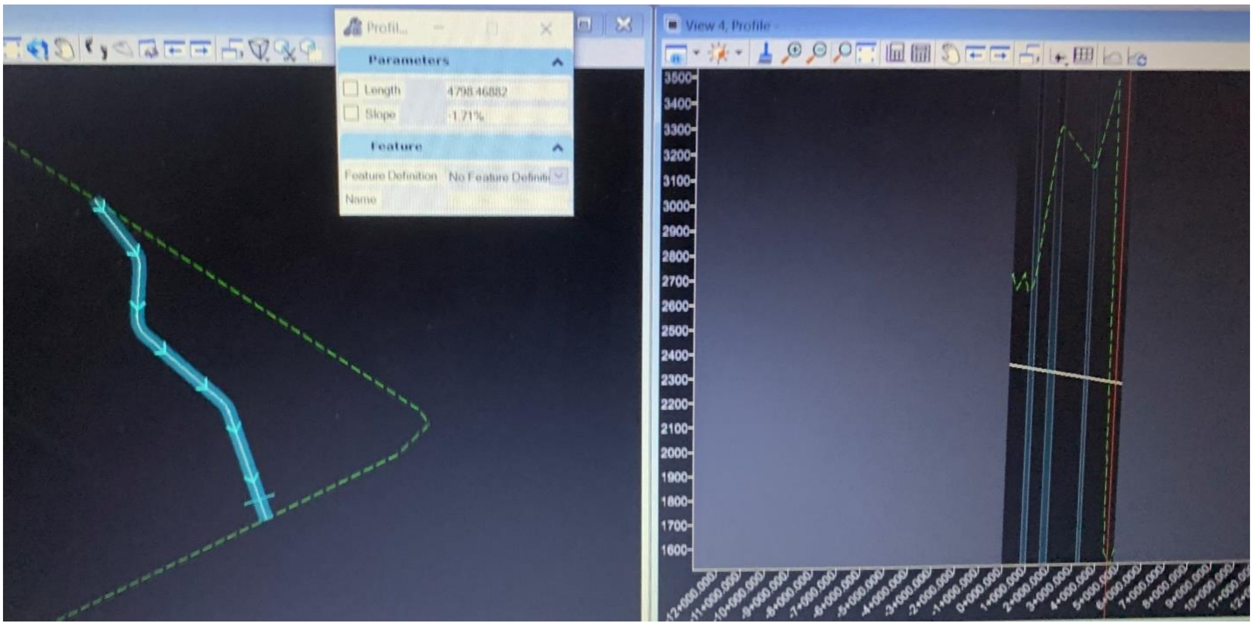



**Figure 4.67**Working Window

Provide slope to pavement design but keeping in view the maximum allowable value of gradient. The maximum allowable value of gradient for mountains terrain is 7%.

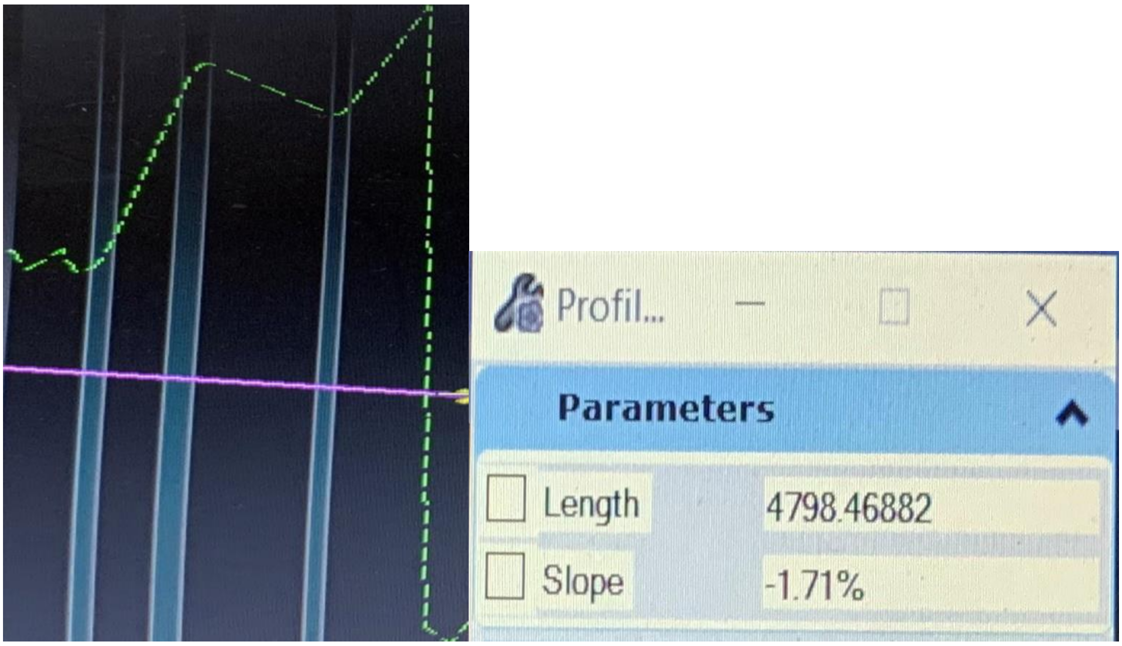



**Figure 4.68** Working Window

Provide a slope of 1.71% to the total 4.8 KM length of the road. (here in starting of vertical profile cutting is need to be done and in the end point landfill)

Now the next part in design is calculation of superelevation.

First select the road for which to superelevation has to be calculated.

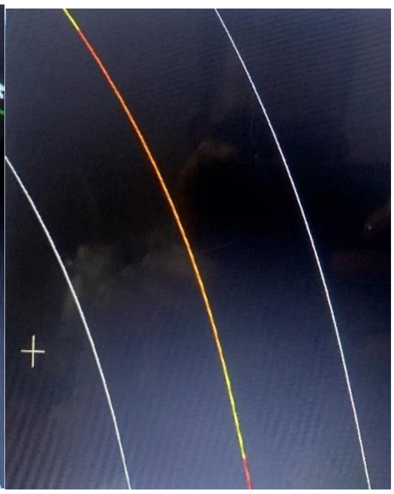
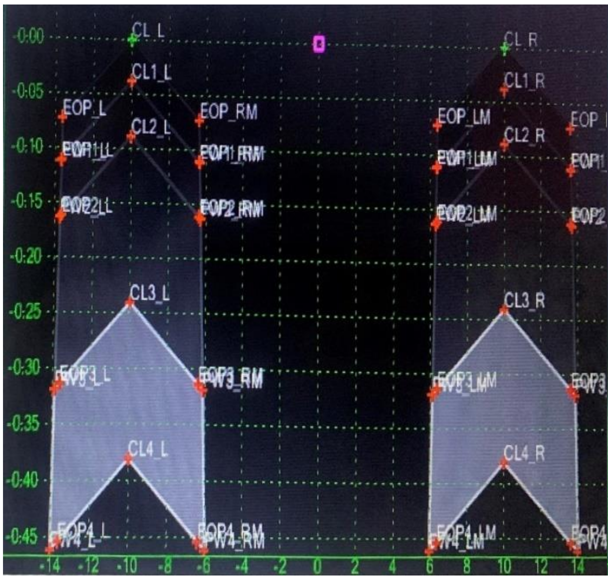


**Figure 4.69** Working Window **Figure 4.70**Working Window

Now select the pavement automatically these boundaries formed across the pavement can see in fig 4.62 and zoomed part in fig 4.63

Now select the type of template for which the calculation of superelevation is done.

In template library there is all templates. select Concrete Pavement for our work.



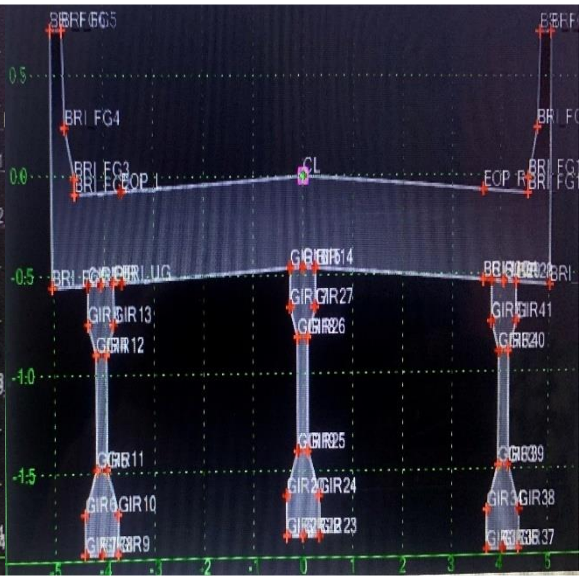


**Figure 4.71** 4Lane Asphalt pavement **Figure 4.72** 2Lane 12Feet Bridge

Select **Concrete Pavement w/ Concrete Shoulder Undivided 2 Lanes**

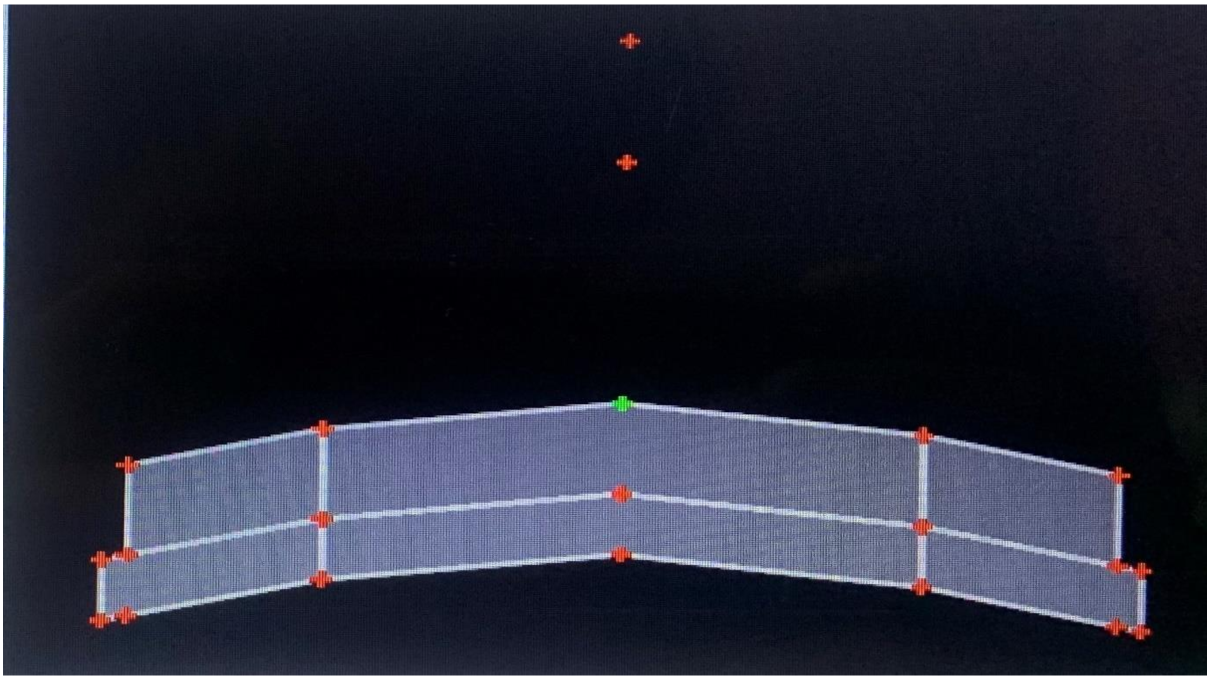


**Figure 4.73** Concrete Pavement w/ Concrete Shoulder Undivided 2 Lanes

For this template calculate superelevation and use this template for final design.

Apply this template to alignment and can see two different lanes for our pavement.

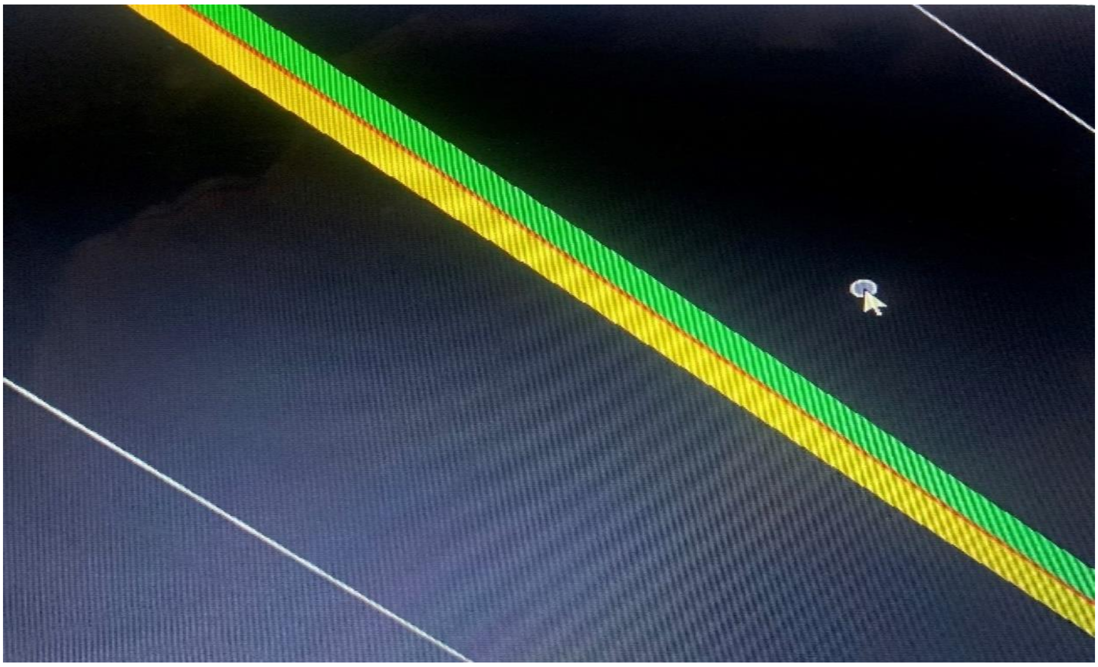


**Figure 4.74** Working Window

Now for the calculation of superelevation select the pivot method.

There is different pivot methods in this software.

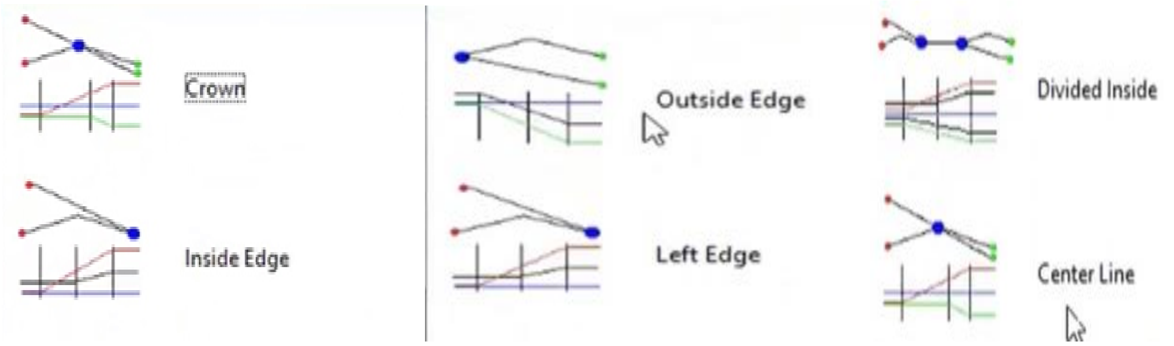



**Figure 4.75** Pivot Method

These all methods of pivoting work on different principle. Different pivot methods are used in different places most common use method is crown method.

In this design use the most basic pivot method which is crown method. Now apply all these values on pavement and the superelevation for this pavement is automatically calculated. (design speed is 60 KMPH, pivot method is crown method)

Now after applying all this values superelevation is calculated. (in this pavement there is two sections these sections are created automatically for calculation of superelevation i.e pavement is converted in two half of equal length only for calculation)

Result of 1st section


| Name | Station | Curve Set | Cross Slope | Transition Type | Pivot Edge | Non Linear Curv... | Point Type | Ignore |
|---|---|---|---|---|---|---|---|---|
| CL - EOP_R - 0+... | 0+784.312 | 0 | -5.33% | Linear | Left Edge | | Full Super | False |
| CL - EOP_R - 1+... | 1+018.736 | 0 | -5.33% | Linear | Left Edge | | Full Super | False |
| CL - EOP_R - 1+... | 1+037.479 | 0 | -2.00% | Linear | Left Edge | | Normal Crown | False |
| CL - EOP_R - 1+... | 1+607.944 | 0 | -2.00% | Linear | Left Edge | | Normal Crown | False |
| CL - EOP_R - 1+... | 1+619.201 | 0 | 0.00% | Linear | Left Edge | | Super Runoff | False |
| CL - EOP_R - 1+... | 1+630.458 | 0 | 2.00% | Linear | Left Edge | | Reverse Crown | False |
| CL - EOP_R - 1+... | 1+649.201 | 0 | 5.33% | Linear | Left Edge | | Full Super | False |
| CL - EOP_R - 1+... | 1+893.046 | 0 | 5.33% | Linear | Left Edge | | Full Super | False |

**Figure 4.76** Result (Table Editor Superelevation Report)

| Name | Station | Curve Set | Cross Slope | Transition Type | Pivot Edge | Non Linear Curv... | Point Type | Ignore |
|---|---|---|---|---|---|---|---|---|
| CL - EOP_L - 1+0... | 1+048.736 | 0 | 0.00% | Linear | Right Edge | | Super Runoff | False |
| CL - EOP_L - 1+0... | 1+059.993 | 0 | -2.00% | Linear | Right Edge | | Normal Crown | False |
| CL - EOP_L - 1+6... | 1+630.458 | 0 | -2.00% | Linear | Right Edge | | Normal Crown | False |
| CL - EOP_L - 1+6... | 1+649.201 | 0 | -5.33% | Linear | Right Edge | | Full Super | False |
| CL - EOP_L - 1+8... | 1+893.046 | 0 | -5.33% | Linear | Right Edge | | Full Super | False |
| CL - EOP_L - 1+9... | 1+911.789 | 0 | -2.00% | Linear | Right Edge | | Normal Crown | False |
| CL - EOP_L - 2+5... | 2+530.666 | 0 | -2.00% | Linear | Right Edge | | Normal Crown | False |
| CL - EOP_R - 0+... | 0+011.640 | 0 | -2.00% | Linear | Left Edge | | Normal Crown | False |

**Figure 4.77** Result (Table Editor Superelevation Report)

Now in this Table editor Superelevation Report there is cross slope of this pavement at different points and also can see which edge is pivot for providing superelevation.

Result of 2nd section

| Name | Station | Curve Set | Cross Slope | Transition Type | Pivot Edge | Non Linear Curv... | Point Type | Ignore |
|---|---|---|---|---|---|---|---|---|
| CL - EOP_L - 2+5... | 2+530.666 | 0 | -2.00% | Linear | Right Edge | | Normal Crown | False |
| CL - EOP_L - 3+1... | 3+147.129 | 0 | -2.00% | Linear | Right Edge | | Normal Crown | False |
| CL - EOP_L - 3+1... | 3+158.386 | 0 | 0.00% | Linear | Right Edge | | Super Runoff | False |
| CL - EOP_L - 3+1... | 3+169.643 | 0 | 2.00% | Linear | Right Edge | | Reverse Crown | False |
| CL - EOP_L - 3+1... | 3+188.386 | 0 | 5.33% | Linear | Right Edge | | Full Super | False |
| CL - EOP_L - 3+3... | 3+313.619 | 0 | 5.33% | Linear | Right Edge | | Full Super | False |
| CL - EOP_L - 3+3... | 3+332.362 | 0 | 2.00% | Linear | Right Edge | | Reverse Crown | False |
| CL - EOP_L - 3+3... | 3+343.619 | 0 | 0.00% | Linear | Right Edge | | Super Runoff | False |

**Figure 4.78**Result (Table Editor Superelevation Report)

| Name | Station | Curve Set | Cross Slope | Transition Type | Pivot Edge | Non Linear Curv... | Point Type | Ignore |
|---|---|---|---|---|---|---|---|---|
| CL - EOP_L - 3+3... | 3+343.619 | 0 | 0.00% | Linear | Right Edge | | Super Runoff | False |
| CL - EOP_L - 3+3... | 3+354.876 | 0 | -2.00% | Linear | Right Edge | | Normal Crown | False |
| CL - EOP_L - 4+8... | 4+806.780 | 0 | -2.00% | Linear | Right Edge | | Normal Crown | False |
| CL - EOP_R - 2+... | 2+530.666 | 0 | -2.00% | Linear | Left Edge | | Normal Crown | False |
| CL - EOP_R - 3+... | 3+169.643 | 0 | -2.00% | Linear | Left Edge | | Normal Crown | False |
| CL - EOP_R - 3+... | 3+188.386 | 0 | -5.33% | Linear | Left Edge | | Full Super | False |
| CL - EOP_R - 3+... | 3+313.619 | 0 | -5.33% | Linear | Left Edge | | Full Super | False |
| CL - EOP_R - 3+... | 3+332.362 | 0 | -2.00% | Linear | Left Edge | | Normal Crown | False |

**Figure 4.79**Result (Table Editor Superelevation Report)

These are the superelevation table editor reports of the pavement.

Now apply these value to pavement and analyse it.

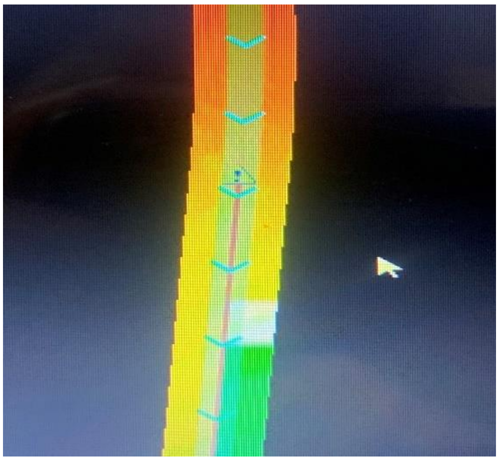


**Figure 4.80**Result (superelevated pavement section)

Pavement sections after applying superelevation values.

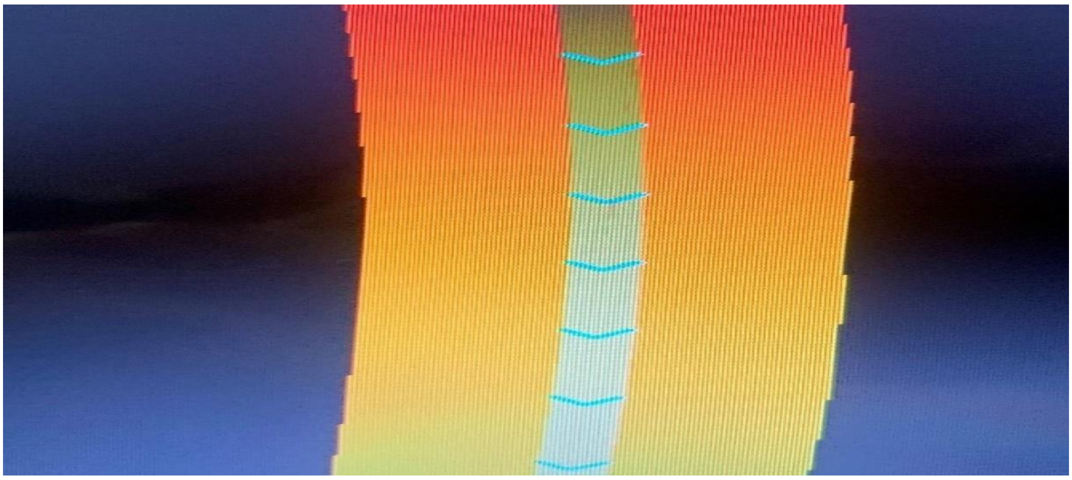


**Figure 4.81**Result (superelevated pavement section)

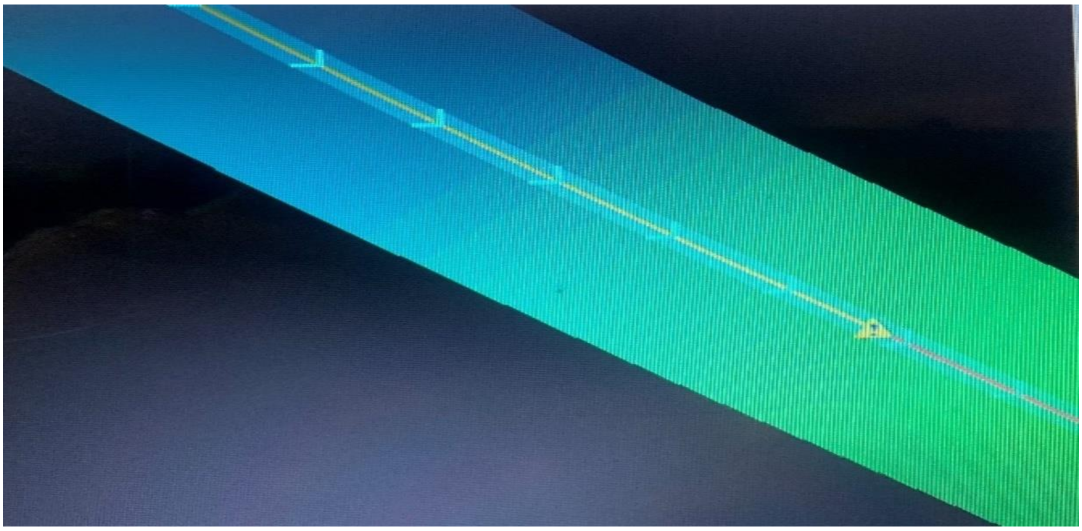


**Figure 4.82**Result (superelevated pavement section)

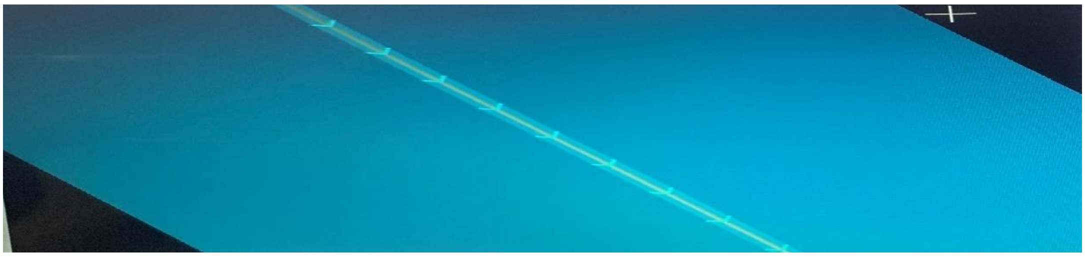
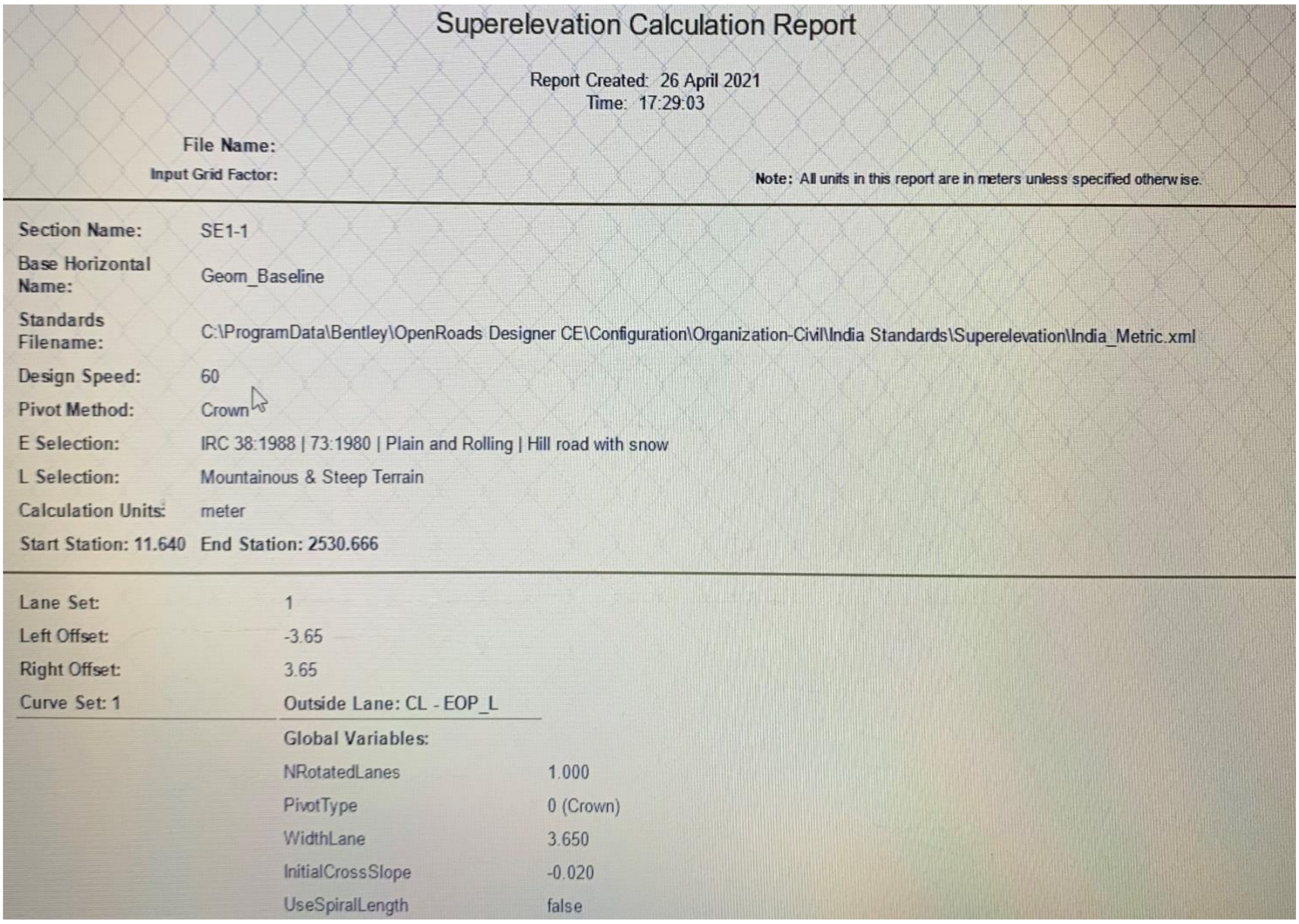


**Figure 4.83**Result (superelevated pavement section)

Here different section of alignment with different colour coding. The orange colour has highest elevation then yellow then purple then blue and then green has least elevation and all these values are safe.

Final Superelevation Calculation Report.



## Superelevation Calculation Report

Report Created: 26 April 2021
Time: 17:29:03

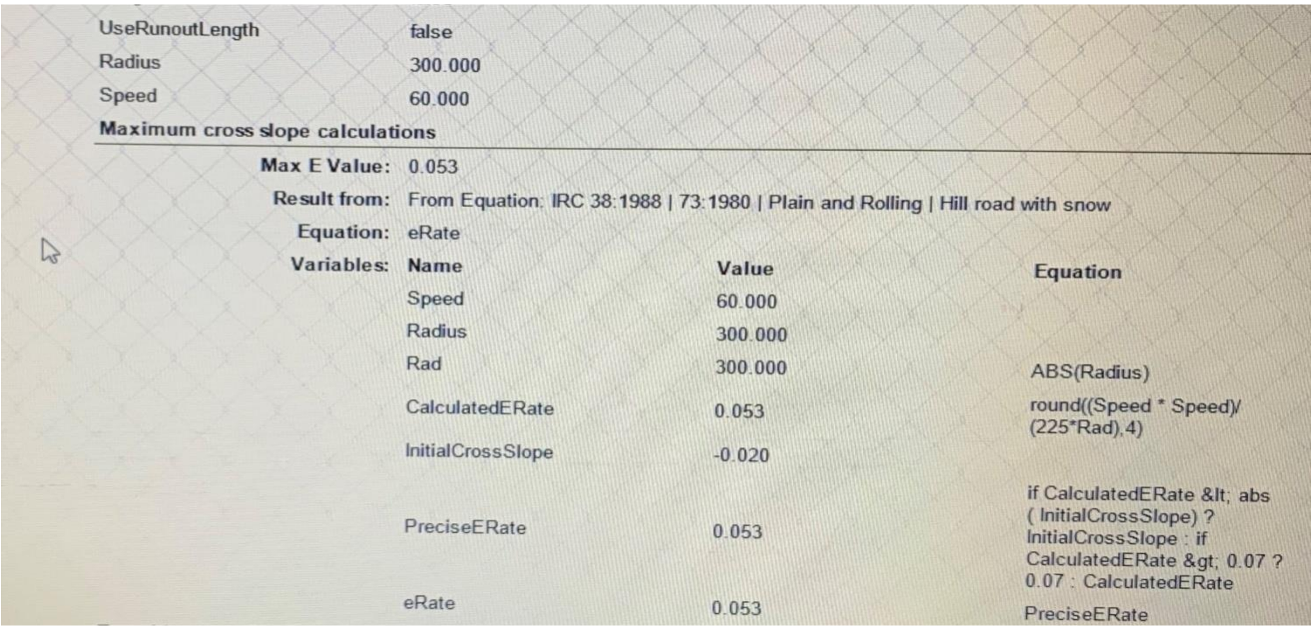
File Name:
Input Grid Factor:

Note: All units in this report are in meters unless specified otherwise.

| | |
|---|---|
| Section Name: | SE1-1 |
| Base Horizontal Name: | Geom_Baseline |
| Standards Filename: | C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\Organization-Civil\India Standards\Superelevation\India_Metric.xml |
| Design Speed: | 60 |
| Pivot Method: | Crown |
| E Selection: | IRC 38:1988 \| 73:1980 \| Plain and Rolling \| Hill road with snow |
| L Selection: | Mountainous & Steep Terrain |
| Calculation Units: | meter |
| Start Station: 11.640 | End Station: 2530.666 |

| | | |
|---|---|---|
| Lane Set: | 1 | |
| Left Offset: | -3.65 | |
| Right Offset: | 3.65 | |
| Curve Set: 1 | Outside Lane: CL - EOP_L | |
| | Global Variables: | |
| | NRotatedLanes | 1.000 |
| | PivotType | 0 (Crown) |
| | WidthLane | 3.650 |
| | InitialCrossSlope | -0.020 |
| | UseSpiralLength | false |

**Figure 4.84**Result (Superelevation Report)

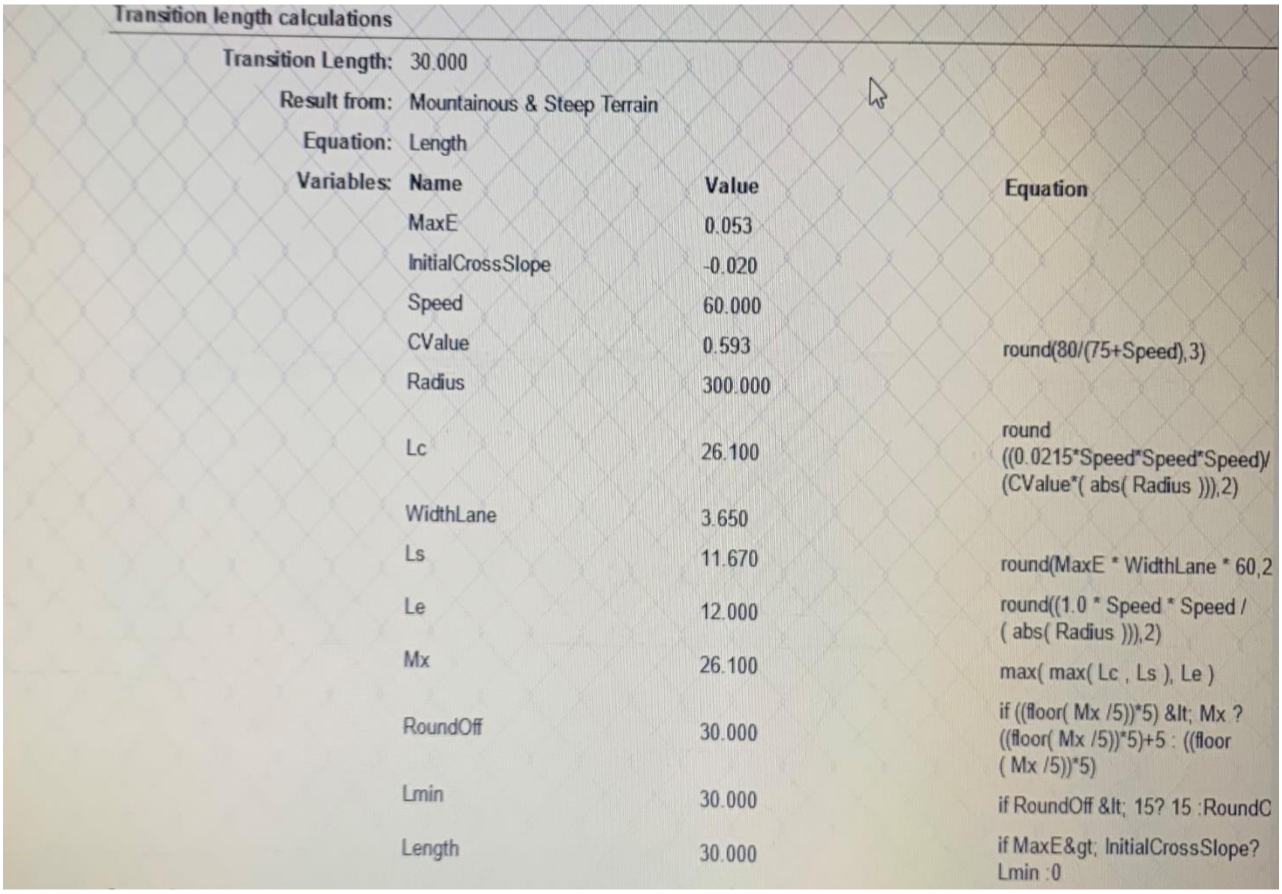


| | |
|---|---|
| UseRunoutLength | false |
| Radius | 300.000 |
| Speed | 60.000 |

**Maximum cross slope calculations**

| | | | |
|---|---|---|---|
| Max E Value: | 0.053 | | |
| Result from: | From Equation: IRC 38:1988 \| 73:1980 \| Plain and Rolling \| Hill road with snow | | |
| Equation: | eRate | | |
| Variables: | Name | Value | Equation |
| | Speed | 60.000 | |
| | Radius | 300.000 | |
| | Rad | 300.000 | ABS(Radius) |
| | CalculatedERate | 0.053 | round((Speed * Speed)/(225*Rad),4) |
| | InitialCrossSlope | -0.020 | |
| | PreciseERate | 0.053 | if CalculatedERate < abs ( InitialCrossSlope) ? InitialCrossSlope : if CalculatedERate > 0.07 ? 0.07 : CalculatedERate |
| | eRate | 0.053 | PreciseERate |

**Figure 4.85**Result (Superelevation Report)



**Transition length calculations**

Transition Length: 30.000

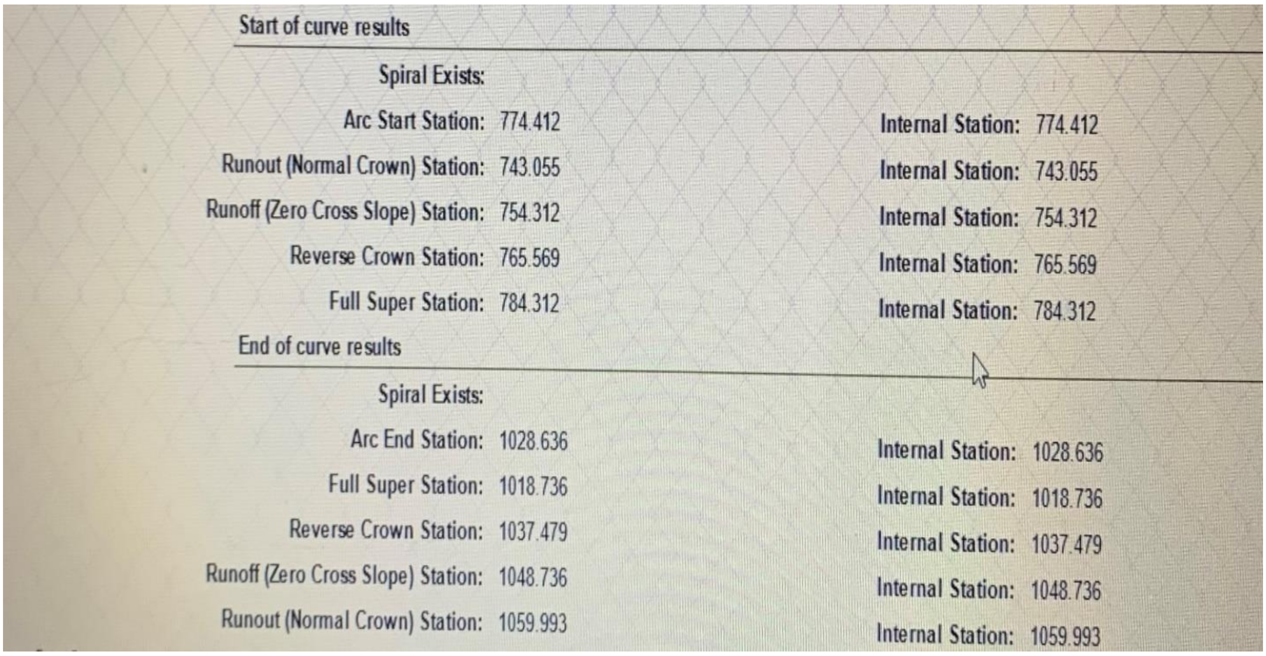
Result from: Mountainous & Steep Terrain

Equation: Length

Variables:

| Name | Value | Equation |
|---|---|---|
| MaxE | 0.053 | |
| InitialCrossSlope | -0.020 | |
| Speed | 60.000 | |
| CValue | 0.593 | round(80/(75+Speed),3) |
| Radius | 300.000 | |
| Lc | 26.100 | round ((0.0215*Speed*Speed*Speed)/ (CValue*( abs( Radius ))),2) |
| WidthLane | 3.650 | |
| Ls | 11.670 | round(MaxE * WidthLane * 60,2 |
| Le | 12.000 | round((1.0 * Speed * Speed / ( abs( Radius ))),2) |
| Mx | 26.100 | max( max( Lc , Ls ), Le ) |
| RoundOff | 30.000 | if ((floor( Mx /5))*5) < Mx ? ((floor( Mx /5))*5)+5 : ((floor ( Mx /5))*5) |
| Lmin | 30.000 | if RoundOff < 15? 15 :RoundC |
| Length | 30.000 | if MaxE> InitialCrossSlope? Lmin :0 |

**Figure 4.86**Result (Superelevation Report)



**Start of curve results**

Spiral Exists:

| | | | |
|---|---|---|---|
| Arc Start Station: | 774.412 | Internal Station: | 774.412 |
| Runout (Normal Crown) Station: | 743.055 | Internal Station: | 743.055 |
| Runoff (Zero Cross Slope) Station: | 754.312 | Internal Station: | 754.312 |
| Reverse Crown Station: | 765.569 | Internal Station: | 765.569 |
| Full Super Station: | 784.312 | Internal Station: | 784.312 |

**End of curve results**

Spiral Exists:

| | | | |
|---|---|---|---|
| Arc End Station: | 1028.636 | Internal Station: | 1028.636 |
| Full Super Station: | 1018.736 | Internal Station: | 1018.736 |
| Reverse Crown Station: | 1037.479 | Internal Station: | 1037.479 |
| Runoff (Zero Cross Slope) Station: | 1048.736 | Internal Station: | 1048.736 |
| Runout (Normal Crown) Station: | 1059.993 | Internal Station: | 1059.993 |

**Figure 4.87**Result (Superelevation Report)

In 1st section we have two curves. So, this calculation for 2nd curve.

**Maximum cross slope calculations**

**Max E Value:** 0.053

**Result from:** From Equation: IRC 38:1988 | 73:1980 | Plain and Rolling | Hill road with snow

**Equation:** eRate

**Variables:**

| Name | Value | Equation |
|---|---|---|
| Speed | 60.000 | |
| Radius | -300.000 | |
| Rad | 300.000 | ABS(Radius) |
| CalculatedERate | 0.053 | round((Speed * Speed)/ (225*Rad),4) |
| InitialCrossSlope | -0.020 | |
| PreciseERate | 0.053 | if CalculatedERate < abs ( InitialCrossSlope) ? InitialCrossSlope : if CalculatedERate > 0.07 ? 0.07 : CalculatedERate |
| eRate | 0.053 | PreciseERate |

**Figure 4.88**Result (Superelevation Report)

**Transition length calculations**

**Transition Length:** 30.000

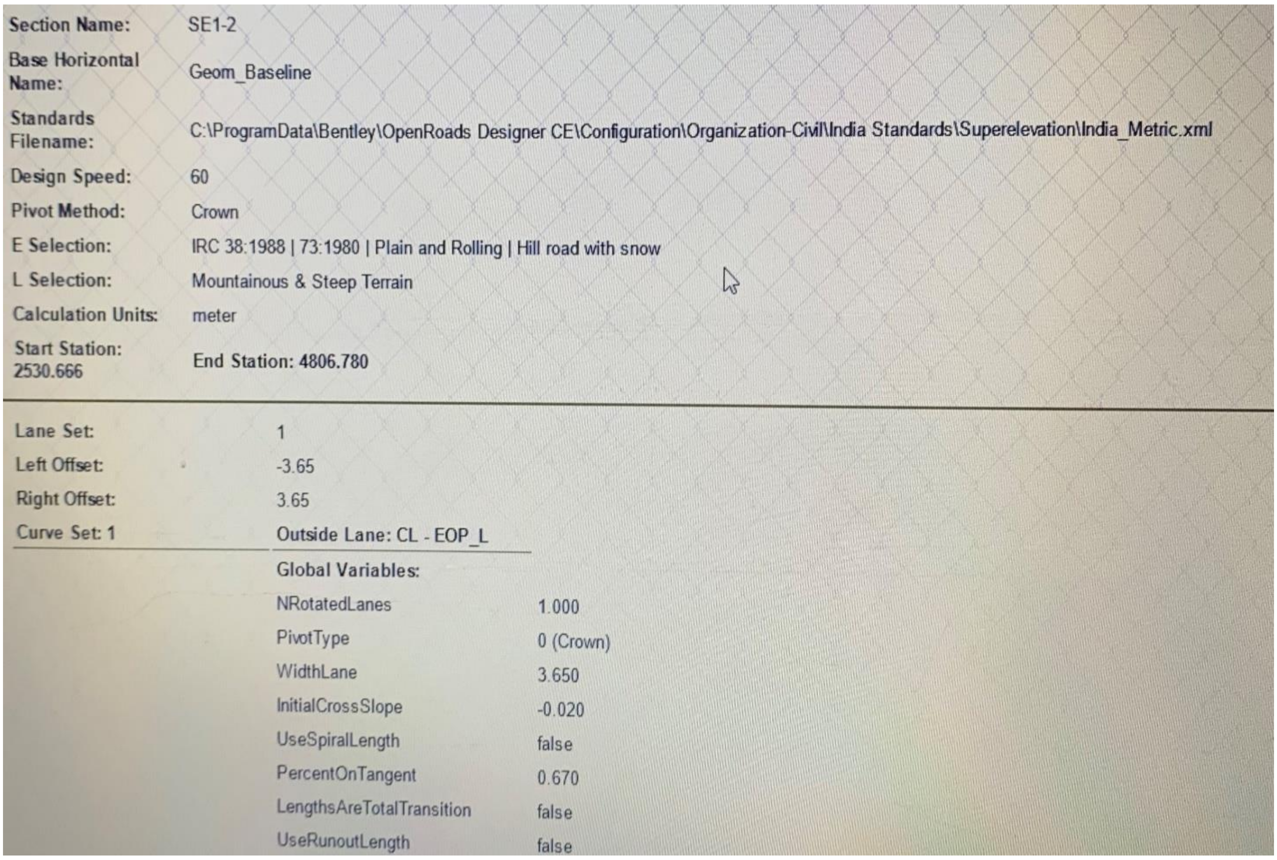
**Result from:** Mountainous & Steep Terrain

**Equation:** Length

**Variables:**

| Name | Value | Equation |
|---|---|---|
| MaxE | 0.053 | |
| InitialCrossSlope | -0.020 | |
| Speed | 60.000 | |
| CValue | 0.593 | round(80/(75+Speed),3) |
| Radius | -300.000 | |
| Lc | 26.100 | round ((0.0215*Speed*Speed*Speed)/ (CValue*( abs( Radius ))),2) |
| WidthLane | 3.650 | |
| Ls | 11.670 | round(MaxE * WidthLane * 60,2) |
| Le | 12.000 | round((1.0 * Speed * Speed / ( abs( Radius ))),2) |
| Mx | 26.100 | max( max( Lc , Ls ), Le ) |
| RoundOff | 30.000 | if ((floor( Mx /5))*5) < Mx ? ((floor( Mx /5))*5)+5 : ((floor ( Mx /5))*5) |

**Figure 4.89**Result (Superelevation Report)



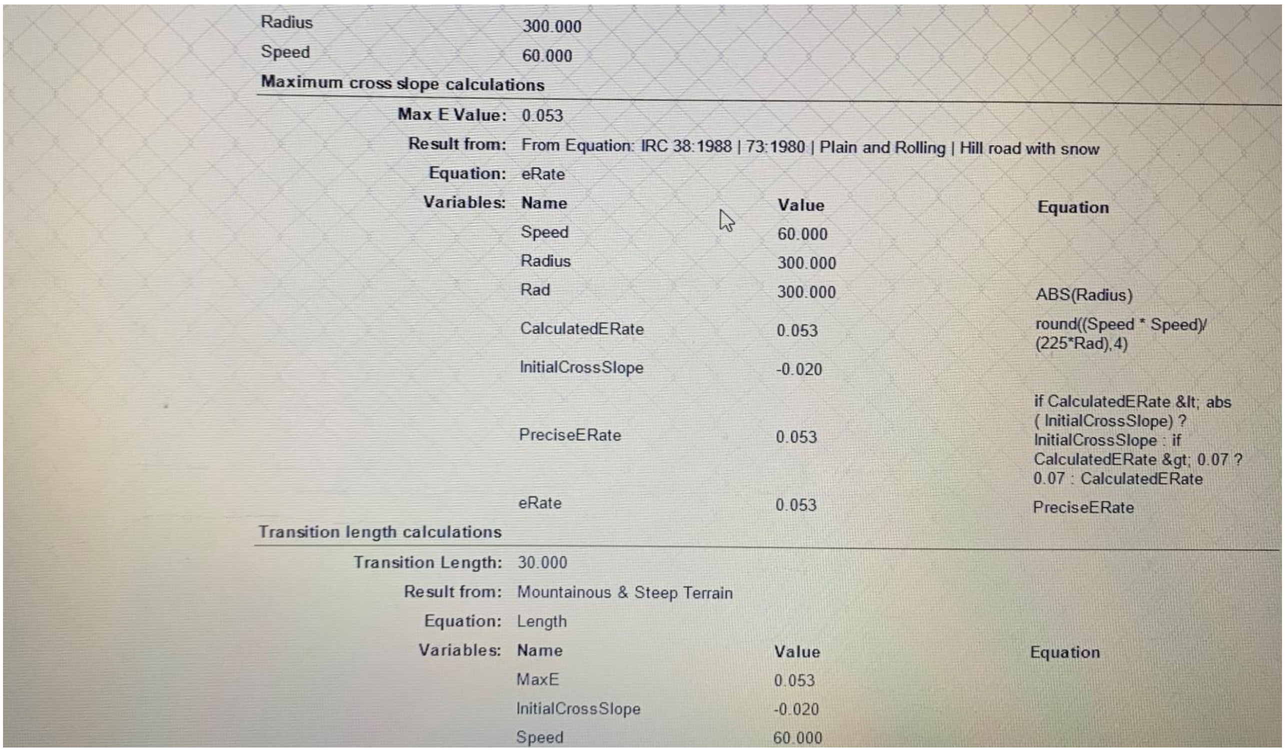
| | |
|---|---|
| Section Name: | SE1-2 |
| Base Horizontal Name: | Geom_Baseline |
| Standards Filename: | C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\Organization-Civil\India Standards\Superelevation\India_Metric.xml |
| Design Speed: | 60 |
| Pivot Method: | Crown |
| E Selection: | IRC 38:1988 \| 73:1980 \| Plain and Rolling \| Hill road with snow |
| L Selection: | Mountainous & Steep Terrain |
| Calculation Units: | meter |
| Start Station: 2530.666 | End Station: 4806.780 |

| | |
|---|---|
| Lane Set: | 1 |
| Left Offset: | -3.65 |
| Right Offset: | 3.65 |
| Curve Set: 1 | Outside Lane: CL - EOP_L |

Global Variables:

| | |
|---|---|
| NRotatedLanes | 1.000 |
| PivotType | 0 (Crown) |
| WidthLane | 3.650 |
| InitialCrossSlope | -0.020 |
| UseSpiralLength | false |
| PercentOnTangent | 0.670 |
| LengthsAreTotalTransition | false |
| UseRunoutLength | false |

**Figure 4.90**Result (Superelevation Report)



| | |
|---|---|
| Radius | 300.000 |
| Speed | 60.000 |

Maximum cross slope calculations

Max E Value: 0.053
Result from: From Equation: IRC 38:1988 | 73:1980 | Plain and Rolling | Hill road with snow
Equation: eRate
Variables:

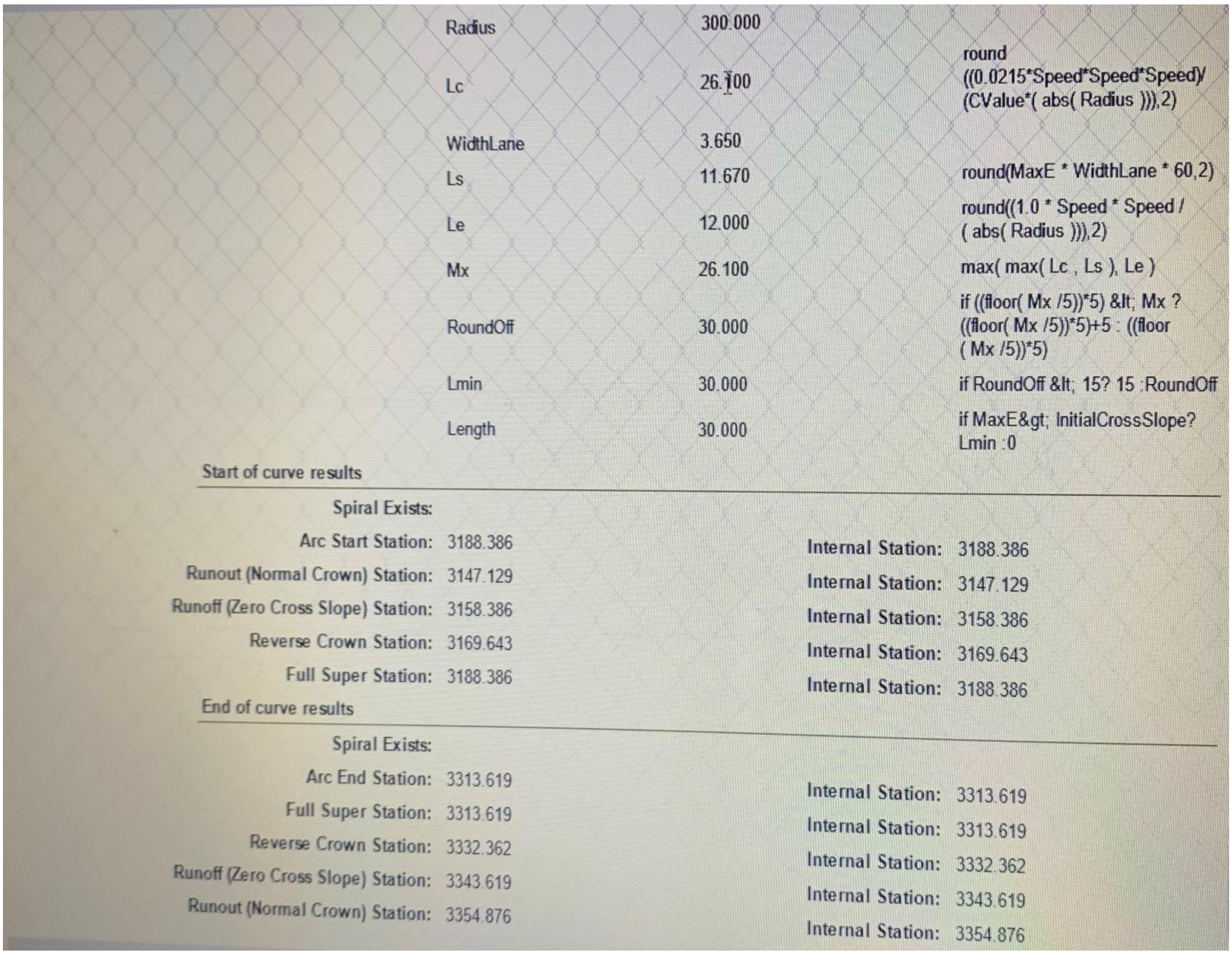
| Name | Value | Equation |
|---|---|---|
| Speed | 60.000 | |
| Radius | 300.000 | |
| Rad | 300.000 | ABS(Radius) |
| CalculatedERate | 0.053 | round((Speed * Speed)/ (225*Rad),4) |
| InitialCrossSlope | -0.020 | |
| PreciseERate | 0.053 | if CalculatedERate < abs ( InitialCrossSlope) ? InitialCrossSlope : if CalculatedERate > 0.07 ? 0.07 : CalculatedERate |
| eRate | 0.053 | PreciseERate |

Transition length calculations

Transition Length: 30.000
Result from: Mountainous & Steep Terrain
Equation: Length
Variables:

| Name | Value | Equation |
|---|---|---|
| MaxE | 0.053 | |
| InitialCrossSlope | -0.020 | |
| Speed | 60.000 | |

**Figure 4.91**Result (Superelevation Report)



| | | |
|---|---|---|
| Radius | 300.000 | |
| Lc | 26.100 | round ((0.0215*Speed*Speed*Speed)/ (CValue*( abs( Radius ))),2) |
| WidthLane | 3.650 | |
| Ls | 11.670 | round(MaxE * WidthLane * 60,2) |
| Le | 12.000 | round((1.0 * Speed * Speed / ( abs( Radius ))),2) |
| Mx | 26.100 | max( max( Lc , Ls ), Le ) |
| RoundOff | 30.000 | if ((floor( Mx /5))*5) < Mx ? ((floor( Mx /5))*5)+5 : ((floor ( Mx /5))*5) |
| Lmin | 30.000 | if RoundOff < 15? 15 :RoundOff |
| Length | 30.000 | if MaxE> InitialCrossSlope? Lmin :0 |

Start of curve results

| | | | |
|---|---|---|---|
| Spiral Exists: | | | |
| Arc Start Station: | 3188.386 | Internal Station: | 3188.386 |
| Runout (Normal Crown) Station: | 3147.129 | Internal Station: | 3147.129 |
| Runoff (Zero Cross Slope) Station: | 3158.386 | Internal Station: | 3158.386 |
| Reverse Crown Station: | 3169.643 | Internal Station: | 3169.643 |
| Full Super Station: | 3188.386 | Internal Station: | 3188.386 |

End of curve results

| | | | |
|---|---|---|---|
| Spiral Exists: | | | |
| Arc End Station: | 3313.619 | Internal Station: | 3313.619 |
| Full Super Station: | 3313.619 | Internal Station: | 3313.619 |
| Reverse Crown Station: | 3332.362 | Internal Station: | 3332.362 |
| Runoff (Zero Cross Slope) Station: | 3343.619 | Internal Station: | 3343.619 |
| Runout (Normal Crown) Station: | 3354.876 | Internal Station: | 3354.876 |

**Figure 4.92**Result (Superelevation Report)

These all are the superelevation calculation data.

Superelevation Cross Slope Report.

## Superelevation Cross Slope Report

Report Created: 26 April 2021
Time: 17:33:01

File Name:
Input Grid Factor:

**Note:** All units in this report are in meters unless specified otherwise.

| | |
|---|---|
| **Section Name:** | SE1-1 |
| **Base Horizontal Name:** | Geom_Baseline |
| **Standards Filename:** | C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\Organization-Civil\India Standards\Superelevation\India_Metric.xml |
| **Design Speed:** | 60 |
| **Pivot Method:** | Crown |
| **E Selection:** | IRC 38:1988 \| 73:1980 \| Plain and Rolling \| Hill road with snow |
| **L Selection:** | Mountainous & Steep Terrain |

**Superelevation: CL - EOP_L**

| Station | Width | Drop/Rise | Cross Slope | ROC% |
|---|---|---|---|---|
| 11.640 | 3.650 | -0.073 | -0.020 | |
| 743.055 | 3.650 | -0.073 | -0.020 | |
| 754.312 | 3.650 | 0.000 | 0.000 | 0.178 |
| 765.569 | 3.650 | 0.073 | 0.020 | 0.178 |
| 784.312 | 3.650 | 0.195 | 0.053 | 0.178 |
| 1018.736 | 3.650 | 0.195 | 0.053 | |
| 1037.479 | 3.650 | 0.073 | 0.020 | -0.178 |
| 1048.736 | 3.650 | 0.000 | 0.000 | -0.178 |

**Figure 4.93**Result (Superelevation Report)

| Station | Width | Drop/Rise | Cross Slope | ROC% |
|---|---|---|---|---|
| 1649.201 | 3.650 | -0.195 | -0.053 | -0.178 |
| 1893.046 | 3.650 | -0.195 | -0.053 | |
| 1911.789 | 3.650 | -0.073 | -0.020 | 0.178 |
| 2530.666 | 3.650 | -0.073 | -0.020 | |

**Superelevation: CL - EOP_R**

| Station | Width | Drop/Rise | Cross Slope | ROC% |
|---|---|---|---|---|
| 11.640 | 3.650 | -0.073 | -0.020 | |
| 765.569 | 3.650 | -0.073 | -0.020 | |
| 784.312 | 3.650 | -0.195 | -0.053 | -0.178 |
| 1018.736 | 3.650 | -0.195 | -0.053 | |
| 1037.479 | 3.650 | -0.073 | -0.020 | 0.178 |
| 1607.944 | 3.650 | -0.073 | -0.020 | |
| 1619.201 | 3.650 | 0.000 | 0.000 | 0.178 |

**Figure 4.94**Result (Superelevation Report)

| | | | | |
|---|---|---|---|---|
| 1630.458 | 3.650 | 0.073 | 0.020 | 0.178 |
| 1649.201 | 3.650 | 0.195 | 0.053 | 0.178 |
| 1893.046 | 3.650 | 0.195 | 0.053 | |
| 1911.789 | 3.650 | 0.073 | 0.020 | -0.178 |
| 1923.046 | 3.650 | 0.000 | 0.000 | -0.178 |
| 1934.303 | 3.650 | -0.073 | -0.020 | -0.178 |
| 2530.666 | 3.650 | -0.073 | -0.020 | |

**Figure 4.95** Result (Superelevation Report)

| | |
|---|---|
| Section Name: | SE1-2 |
| Base Horizontal Name: | Geom_Baseline |
| Standards Filename: | C:\ProgramData\Bentley\OpenRoads Designer CE\Configuration\Organization-Civil\India Standards\Superelevation\India_Metric.xml |
| Design Speed: | 60 |
| Pivot Method: | Crown |
| E Selection: | IRC 38:1988 \| 73:1980 \| Plain and Rolling \| Hill road with snow |
| L Selection: | Mountainous & Steep Terrain |

Superelevation: CL - EOP_L

| Station | Width | Drop/Rise | Cross Slope | ROC% |
|---|---|---|---|---|
| 2530.666 | 3.650 | -0.073 | -0.020 | |
| 3147.129 | 3.650 | -0.073 | -0.020 | |
| 3158.386 | 3.650 | 0.000 | 0.000 | 0.178 |
| 3169.643 | 3.650 | 0.073 | 0.020 | 0.178 |
| 3188.386 | 3.650 | 0.195 | 0.053 | 0.178 |
| 3313.619 | 3.650 | 0.195 | 0.053 | |
| 3332.362 | 3.650 | 0.073 | 0.020 | -0.178 |
| 3343.619 | 3.650 | 0.000 | 0.000 | -0.178 |
| 3354.876 | 3.650 | -0.073 | -0.020 | -0.178 |
| 4806.780 | 3.650 | -0.073 | -0.020 | |

Superelevation: CL - EOP_R

| Station | Width | Drop/Rise | Cross Slope | ROC% |
|---|---|---|---|---|
| 2530.666 | 3.650 | -0.073 | -0.020 | |
| 3169.643 | 3.650 | -0.073 | -0.020 | |
| 3188.386 | 3.650 | -0.195 | -0.053 | -0.178 |

**Figure 4.96**Result(Superelevation Report)

Now apply all these values and final Rigid Pavement is ready.

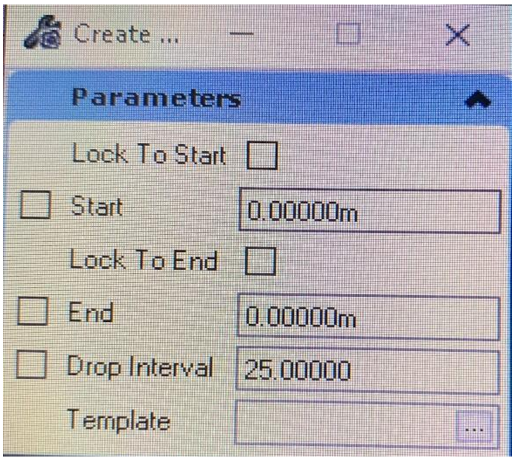



**Figure 4.97**Working Window

Here select the alignment and it automatically take all the data and in template section select Concrete Pavement w/ Concrete Shoulder Undivided 2 Lanes.

Final design of pavement.

**Figure 4.98**Result (Design of Rigid Pavement)

Now these are the different views and in different view styles of final pavement design.

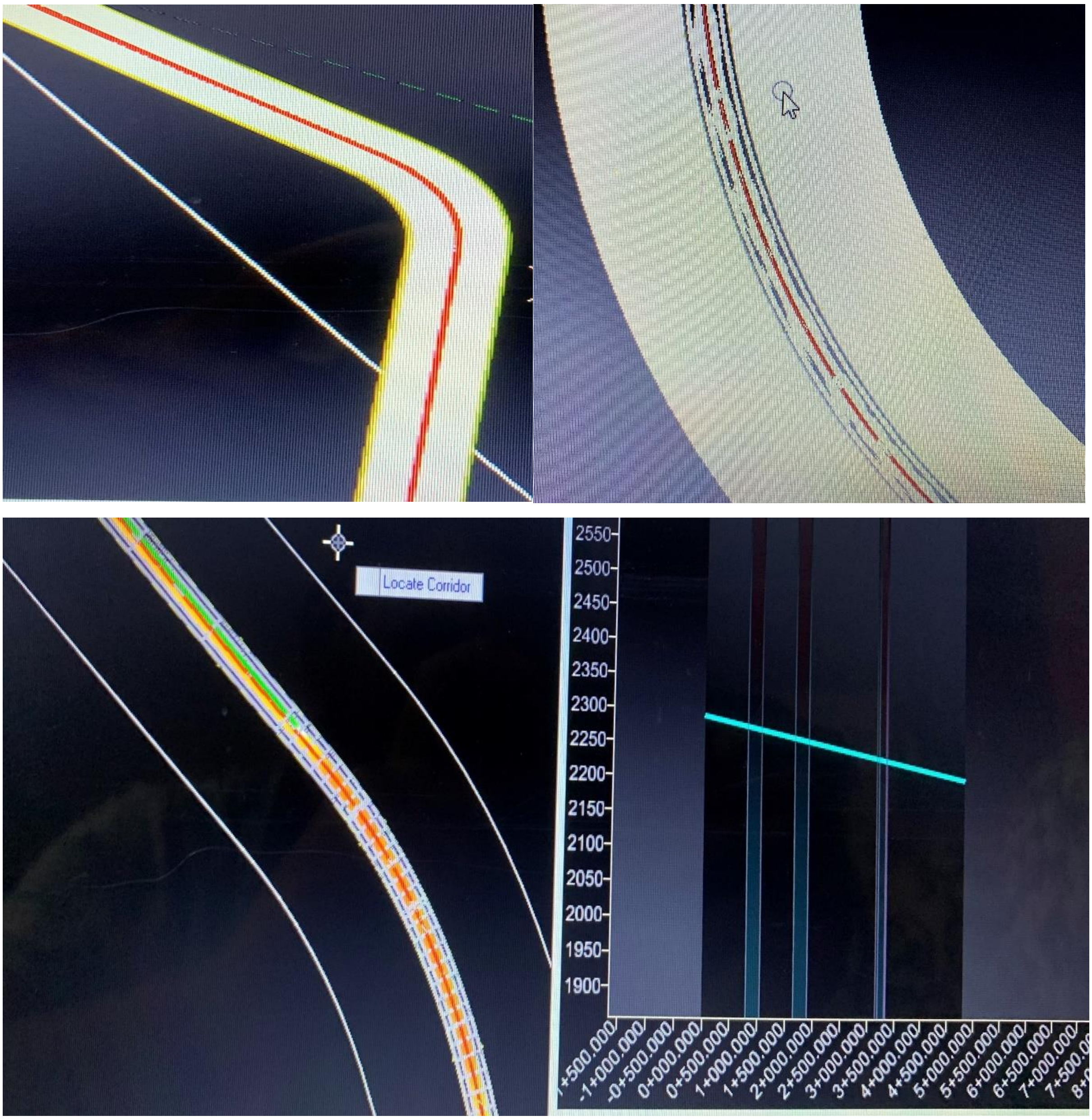



**Figure 4.99**Result (Design of Rigid Pavement)

# CHAPTER 5
# ESTIMATION AND COST

## 5.1 OVERVIEW

For all development works or designing cycles the necessity heretofore is to think about the plausible expense of development which is known as the assessed cost. In the event that the financial plan accessible for the venture is lesser when contrasted with the assessed cost endeavors are made to decrease such expense through lessening the work or by changing certain detail. The prerequisite for setting up a gauge is by computing amounts through mensuration strategies and afterward assessing the expense.

The estimate demonstrated here is for concrete pavement on hilly terrain. Here cost estimation calculations are done for

- Earth work. (cutting and filling)
- Clearing and Grubbing.
- Construction of base and sub base.
- Construction of surface course.
- Construction of shoulders.
- Construction of retaining wall.

## 5.2 COST FOR EARTHWORK.

For calculation of earth work (land cutting and land filling) for pavement of 4.8 KM. Divide the pavement into 5 sections of 960meter length of each section.

**Figure 5.1 Slope of Pervious Path**

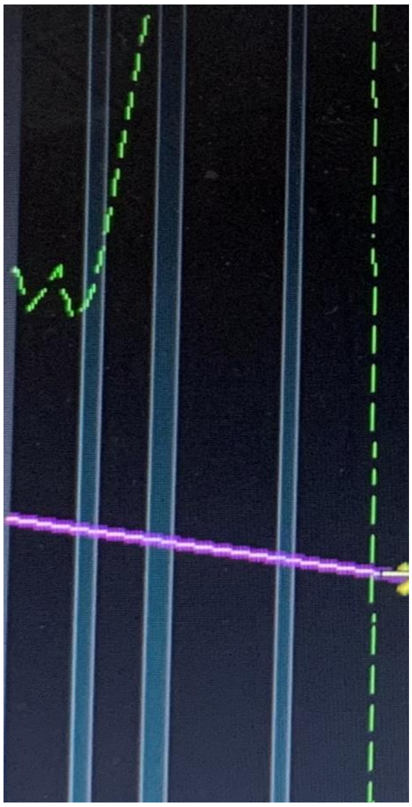


**Figure 5.2 Slope of Pavement**

Mean elevation difference between this pavement and pervious pedestrian path in all 5 sections:

1st section = 18meter.

2nd section = 9 meter.

3rd section = 3 meter.

4th section = 3meter.

5th section= 9meter.

Estimation cost for cutting and filling.

**1st Section**

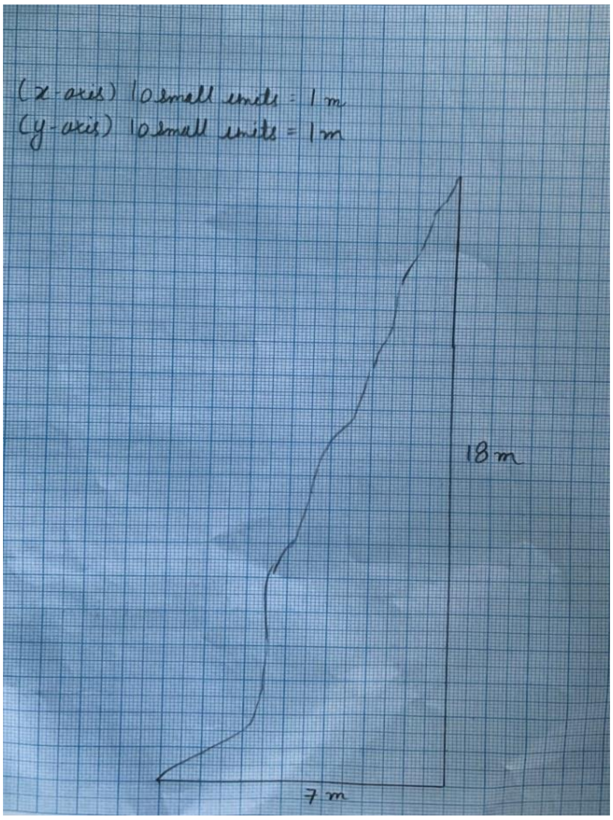



**Figure 5.3 1st Section for Volume Calculation**

Area of this section = 1/2 (18*7)

= 63meter sq.

Length of each section is 960meter

Therefore, Volume of this section = 60,480 cum.

This section of terrain is excavated.

Approximate cost of excavation of Rock = 200 Rupee.

Approximate total cost of excavation of 1st section = 1,20,00,000 Rupee.

**2nd Section**

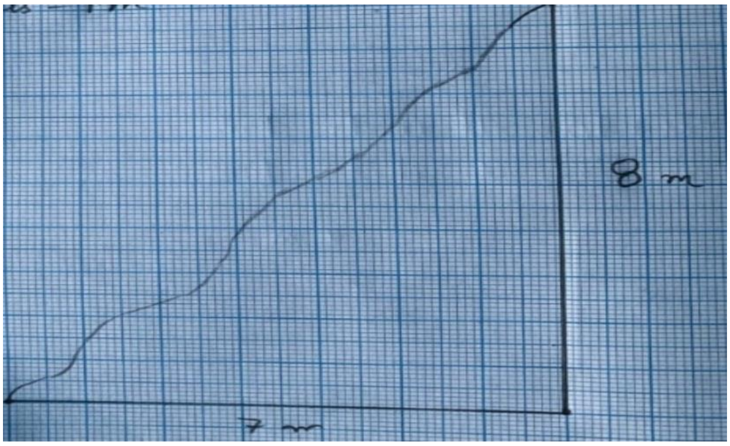



**Figure 5.4 2nd Section for Volume Calculation**

Area of this section = 28meter sq.

Volume of this section = 26,880 cum. (Length of each section is 960meter)

This section of terrain is also excavated.

Approximate total cost of excavation of 2nd section = 54,00,000 Rupee.

**3rd Section**

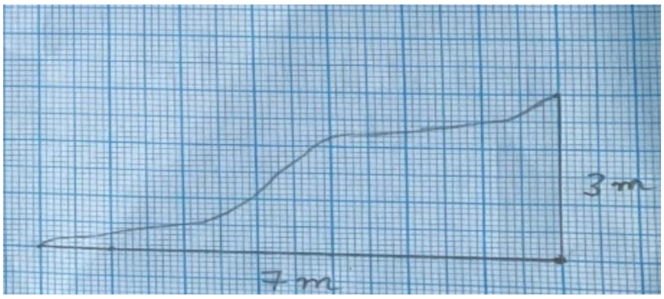



**Figure 5.5 3rd Section for Volume Calculation**

Area of this section = 10.5meter sq.

Volume of this section = 10,080 cum. (Length of each section is 960meter)

This section of terrain is also excavated.

Approximate total cost of excavation of 3rd section = 20,16,000 Rupee.

**4th Section**

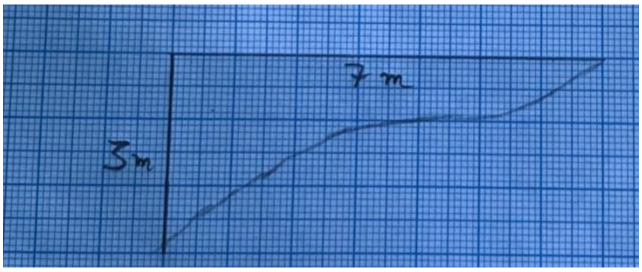



**Figure 5.6 4th Section for Volume Calculation**

Area of this section = 10.5meter sq.

Volume of this section = 10,080 cum. (Length of each section is 960meter)

This section of terrain is filled with rock material which is from excavation section.

Approximate cost of filling = 60 Rupee.

Approximate total cost of filling this section = 6,04,800 Rupee.

**5th section**

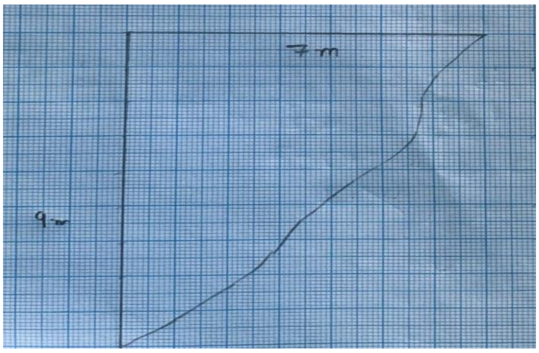



**Figure 5.7 5th section for Volume Calculation**

Area of this section = 28meter sq.

Volume of this section = 26,880 cum.

This section is also filled.

Approximate total cost of filling this section = 16,13,000 Rupee.

**Total Approximate Cost of Cutting and Filling = 2,16,33,800 Rupee**

## 5.3COST OF CLEARIN AND GRUBBING

Clearing and grubbing street land including evacuating rank vegetation, grass, hedges, bushes, saplings and trees bigness up to 300 mm, expulsion of stumps of trees cut before and removal of unserviceable materials.

Cost of clearing and grubbing for light jungle area is Rs 8,000 per Hectare.

Cost of clearing and grubbing for 10000meter sq. = 8,000 Rupee.

Total length of pavement = 4,800 meter.

Take 7meter width for clearing and grubbing cost

Total area for clearing and grubbing = 33,600meter sq.

Approximate Total cost of clearing and grubbing = 27,000 Rupee.

**27,000 Rupee is Approximate Cost for Clearing and Grubbing**.

## 5.4 COST OF CONSTRUCTION OF BASE AND SUB BASE

**Base course**

This is the layer straightforwardly underneath the PCC layer and by and large comprises of total or balanced out subgrade.

**Subbase course**

This is the layer (or layers) under the base layer. A subbase is not always needed and therefore may often be omitted.

Approximate cost material for one cum (Cement Flyash Treated soil) Base = 720 rupee.

Approximate cost material for one cum (Fly ash stabilized soil) sub-base = 520 rupee.

Total length of pavement = 4,800 meter.

Width of undivided lanes = 3.650 meter.

Generally, the thickness of base is 100mm.

Therefore, Total volume of base layer = 1,752 cum.

Approximate Total cost of construction of base = 12,62,000 rupee.

Generally, the thickness of sub-base layer is 150mm.

Therefore, Total volume of sub-base layer = 2,592 cum.

Approximate Total cost of construction of sub-base = 13,50,000 rupee.

**26,12,000 Rupee is Estimated Cost of Construction of Base and Sub base.**

## 5.5 COST OF CONSTRUCTON OF SURFACE LAYER

### Surface Course

The surface course is the layer in contact with traffic loads. It gives qualities like rubbing, perfection, commotion control and waste. What's more, it fills in as a waterproofing layer to the hidden base, subbase and subgrade. The surface course can differ in thickness however is ordinarily between 150 mm (6 inches) (for light stacking) and 300 mm (12 inches) (for hefty burdens and high traffic).

Grade of concrete used for surface layer is M 40.

Total approximate cost of one cum concrete for surface layer = 5,000 rupee.

Total length of the pavement = 4,800 meter.

Width of undivided lanes = 3.650 meter.

Generally, the thickness of surface layer is between 150mm to 300mm.

Therefore, Total volume for surface layer = 2628 cum.

Approximate Total cost of construction of surface layer = 1,31,40,000 Rupee.

**1,31,40,000 Rupee is Approximated Cost of Construction of Surface Layer.**

## 5.6 COST OF CONSTRUCTION OF SHOULDER

**Shoulders**

These are the part given along the carriage approach to offer horizontal help to the asphalt and for giving working space for halted vehicles. Least width of shoulder suggested by IRC is 2.5 meter.

Approximate cost of granular material for construction of shoulder = 660 rupee.

Length of shoulder = 4,800 meter.

Width of shoulder = 3 meter.

Generally, the slope of shoulders is 1:2 at one end.

Therefore, total volume of shoulder = 5,040 cum.

Approximate total cost of construction of shoulder = 33,27,000 rupee.

**33,27,000 Rupee is Approximate Cost of Construction of Shoulder.**

## 5.7 COST OF CONSTRUCTION OF RETAINING WALL

**Retaining walls** are vertical or close vertical constructions intended to hold material on one side, keeping it from falling or slipping or forestalling disintegration. They provide support to terrain where the soil's angle of repose is exceeded and it would otherwise collapse into a more natural form.

Retaining wall provided on upside of pavement.

Use RR masonry for construction of retaining wall.

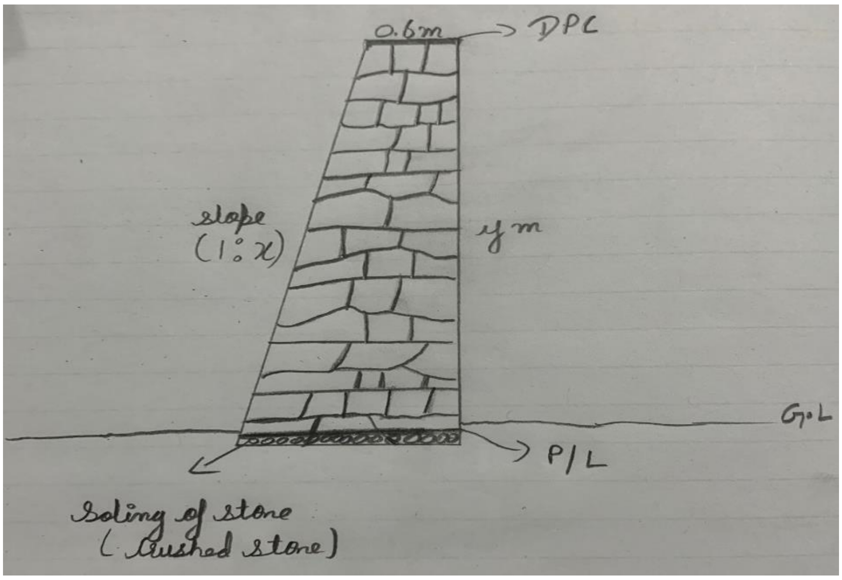



**Figure 5.8 Retaining Wall**

Base width of retaining wall = 0.6 + (slope * height of retaining wall)

Thickness of DPC caping = 0.2meter.

Thickness of soling stone = 0.2meter.

Thickness of (P/L) providing and laying of Cement Concrete = 0.2meter.

In this pavement provide retaining wall to 2880meter length of the road where excavation is done by using RR masonry. (provide retaining wall to 1$^{st}$ 3 sections of pavement)

Providing height of retaining wall as 12 meter in 1$^{st}$ section (960meter) where height of mean excavation is 18meter, height of retaining wall as 6meter in 2$^{nd}$ section(960meter) where height of mean excavation is 9meter and height of retaining wall as 3meter in 3$^{rd}$ section (960meter) where height of mean excavation is 3meter.

Provide slope of 1:4 at 1st section (960meter) where height of retaining wall is 12meter.

Therefore, base width = 0.6 + (1:4 * 12) = 3.6meter.

Provide slope of 1:3 at 2nd section (960meter) where height of retaining wall is 6meter.

Therefore, base width = 0.6 + (1:3 * 6) = 2.6meter.

Provide slope of 1:2 at 3rd section (960meter) where height of retaining wall is meter.

Therefore, base width = 0.6 + (1:2 * 6) = 2.1meter.

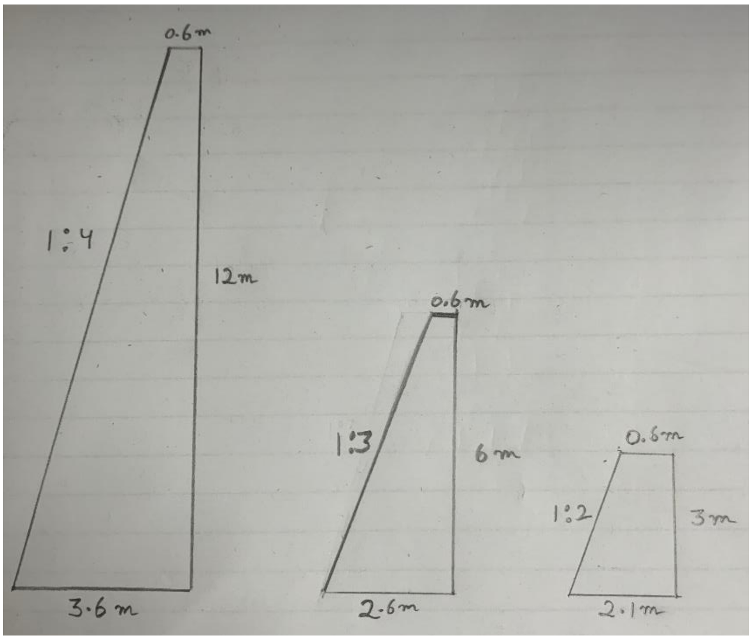



**Figure 5.9 All 3 sections of retaining wall**

## Excavation cost for construction of retaining wall

Depth = 0.9meter.

Volume of excavation = (960*0.9*3.6) + (960*0.9*2.6) + (960*0.9*2.1) = 7172 cum.

Approximate cost of excavation is 200 Rupee per cum.

Approximate cost of excavation = 14,50,000 Rupee.

**Cost for soling of stones**

Depth For soling of stone = 0.3meter

Volume = (960*0.3*3.6) + (960*0.3*2.6) + (960*0.3*2.1) = 2305 cum.

Approximate cost is 600 Rupee for per cum.

Approximate cost for soling if stones = 3,63,000 Rupee

**Cost for laying cement concrete**

Depth = 0.2meter

Volume = (960*0.2*3.6) + (960*0.2*2.6) + (960*0.2*2.1) = 1,592 cum.

Approximate cost is 4,000 Rupee for per cum.

Approximate cost for laying cement concrete = 60,00,000 rupee

**Cost for construction of Random Rubble Masonry wall**

Total volume = 960* (25.2 + 9.6 + 1.9) = 35,232 cum. Approximate cost is 1,400 Rupee for per cum

Approximate cost for construction of RR masonry wall = 4,90,00,000

**Cost for DPC at top**

Thickness = 0.2meter.

Volume = (2880*0.2*0.6) = 345 cum.

Approximate cost of construction is Rupee 7,000 per cum.

Approximate cost for DPC = 24,50,000 Rupee.

Approximate total cost of construction of retaining wall = 5,93,00,000 Rupee

**5,93,00,000 Rupee is approximate cost of construction of Retaining wall**

## 5.8 TOTAL ESTIMATED COST

Estimated cost for cutting and filling = 2,16,33,800 Rupee.

Estimated cost for clearing and grubbing = 27,000 Rupee.

Estimated cost for construction of base and sub-base = 26, 12,000 Rupee.

Estimated cost for construction of surface layer = 1,31,40,000 Rupee.

Estimated cost for construction of shoulder = 33,27,000 Rupee.

Estimated cost for construction of retaining wall = 5,93,00,000 Rupee.

**Total Estimated Cost = 10,00,40,000 + 10% of Total Cost**

# CONCLUSION

In this modern era in Civil Engineering Software learning is essential part. Here in this report design 4.8 KM Undivided 2 Lane Concrete Pavement on Hilly Terrain by using Open Road Software. We used this software because this software supports IRC and **OPEN ROAD** is an excellent string-based modelling tool that enables the rapid and accurate design of a **roads**. The one more most important thing about this software is it can take raw data from any format here in our project we provide raw data from ascii file but it can even take data from GEA.

In this report 1$^{st}$there is a analysis of Hilly Terrain of J&K whose Planar Area and Slope Area Calculated by Software and comes out 4.157E+11meter sq. and 2.0969E+11 respectively, Slope analysis, Height analysis also done by using Software.

Horizontal Geometry is designed 4 straight sections of (1476.83 +1258.85+610.68+754.2) meters and 3 curves of (300+300+300) meters are provided in Alignment and set design speed as 60 KMPH with all IRC. Then check for 100 KMPH is also done but for 100 KMPH extra road length and extra construction cost is required.

Vertical Geometry is designed with keeping in view all allowable maximum and minimum values of vertical gradients recommended by IRC. In this pavement there is 1.71% gradient to whole 4.8 KM length of the pavement. Then superelevation values are Calculated according to the type of pavement which is Undivided 2 Lane Concrete Pavement, type of pivot method which is Crown pivot method and in last these values are applied these to this pavement.

OPEN ROAD SOFTWARE permits clients to share data across different groups, areas, and order in thought to security and accuracy.

Empowers configuration time representation to see the plan on the fly and set aside cash by staying away from programming and staff prerequisite.

# FUTURE SCOPE

Software are the future.

In older times there used to be a lot of work done manually by drafting a plan or Hand drafting. This used to be quite tedious and time consuming process. Now in modern world software have replaced these old methods used in civil engineering. Software are playing a major role in shaping the future of civil engineering. Some of the excellent software used are AutoCAD, Revit, OPEN ROAD SOFTWARE, etc. Having the knowledge of these software can help you in getting better knowledge of the civil and building career options.

One such advanced software used in our study is OPEN ROAD SOFTWARE, a software used for Open Road Modeling, Open Road Drawing Production, Survey, Geotechnical, Reality Modeling, Drawing, Drainage and Utilities. People like structural specialists, planners, assessors, framework fashioners can get to 3D demonstrating, development driven designing, and other examination across the board. Designing application.The software cut downs all the paper work and calculations needed for designing a road profile. Makes work simpler and effective. Software like OPEN ROAD SOFTWARE are gaining popularity as they are able to evaluate data and helps to create great 3d profiles and representations that helps us to create human marvels. With the introduction of these new modern software, old methods will soon loose their significance.

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