DESIGN AND ESTIMATION OF FLEXIBLE PAVEMENT FOR SINGIRI KONA PILGRIMAGE

V S Meganathan[1], R Rajesh Kumar[2], H N Sunil Solanki[3], A Srinivasulu[4]

[1,2] Assistant Professor, Dept. of Civil Engineering, Siddharth Group of Institutions, Puttur, AP, India
[3,4] UG Student, Dept. of Civil Engineering, Siddharth Group of Institutions, Puttur, AP, India

---***---

Abstract-*Transportation plays a major role in the development of the human civilization. For instance, one could easily observe the store correlation between the evolution of human settlement and the proximity of transport facilities also, there is a strong correlation between the quality of transport facilities and standard of living, because of which society place a great expectation from transportation facilities.*

A road is a route or way between two places that has been paved or otherwise improved to allow travel by foot, bicycle, or motor cycle. The extension of rural road network is of vital importance for bringing the social amenities, education, and transportation of agricultural products from tribal villages to market yards and distribution centres.

India is the second largest road network in the world with the total length of around 4,320,000 km. India road network consists of 1000 km expressways, 79,243 km National Highways, 1,31,899 km State highways and other district and rural roads. The total road length in the state of Andhra Pradesh is about 123,334 km with various types of roads such as NH(4,422 km), SH(7,255), Major District(19,783 km) and Rural roads.

The project main aim is to design 6km road way to provide transportation facilities for pilgrims who are going to visit Singiri kona Shri Lakshmi Narasimha swami temple for darshan. Single lane pavement (3.75m wide with 1m shoulder on either side of road) is recommended from keelagaramu, Narayanavanam mandal, chittoor district in Andhra Pradesh and it also covers a small village which located in between two points.

In our program, first we are going to collect longitudinal-section and cross-section levels by using auto level and levelling staff, further we are going to check the CBR value of the existing soil. Based on CBR value total thickness of pavement layers are evaluated for flexible pavement design.

Further step in our project is to estimate the road construction cost for earth work excavation (in terms of cutting & filling), machinery, man power and materials which are used in flexible pavement.

Finally, road design is done for horizontal curves, vertical curves, cross-section elements, transition curve, pipe culvert to drive drain water under based on all above data.

Key Words: *horizontal curves, vertical curves, CBR value, cross-section levels and road design*

1. INTRODUCTION:

Road transport is one of the most common modes of transport. Roads in the form of track ways, human pathways etc. were used even from the pre-historic times. Since then many experiments were going on to make the riding safe and comfort. Thus, road construction became an inseparable part of many civilizations and empires. In this chapter we will discuss about flexible pavement and its different layers with carriageway, earthen shoulder, side slope, drainage, typical cross-section and culvert details in road construction.

A highway pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade, whose primary function is to distribute the applied vehicle loads to the sub-grade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favourable light reflecting characteristics, and low noise pollution. The ultimate aim is to ensure that the transmitted stresses due to wheel load are sufficiently reduced, so that they will not exceed bearing capacity of the sub-grade. Two types of pavements are generally recognized as serving this purpose, namely flexible pavements and rigid pavements. This chapter gives an overview of pavement types, layers, and their functions, and pavement failures. Improper design of pavements leads to early failure of pavements affecting the riding quality.

An ideal pavement should meet the following requirements:

- Sufficient thickness to distribute the wheel load stresses to a safe value on the sub-grade soil,
- Structurally strong to withstand all types of stresses imposed upon it,
- Adequate coefficient of friction to prevent skidding of vehicles,
- Smooth surface to provide comfort to road users even at high speed,
- Produce least noise from moving vehicles,
- Dust proof surface so that traffic safety is not impaired by reducing visibility,

The pavements can be classified based on the structural performance into two, flexible pavements and rigid pavements. In flexible pavements, wheel loads are transferred by grain-to-grain contact of the aggregate through the granular structure. The flexible pavement, having less flexural strength, acts like a flexible sheet (e.g. bituminous road). On the contrary, in rigid pavements, wheel loads are transferred to sub-grade soil by flexural strength of the pavement and the pavement acts like a rigid plate (e.g. cement concrete roads). In addition to these, composite pavements are also available. A thin layer of flexible pavement over rigid pavement is an ideal pavement with most desirable characteristics. However, such pavements are rarely used in new construction because of high cost and complex analysis required.

Flexible pavements will transmit wheel load stresses to the lower layers by grain-to-grain transfer through the points of contact in the granular structure (see Figure 1.1).

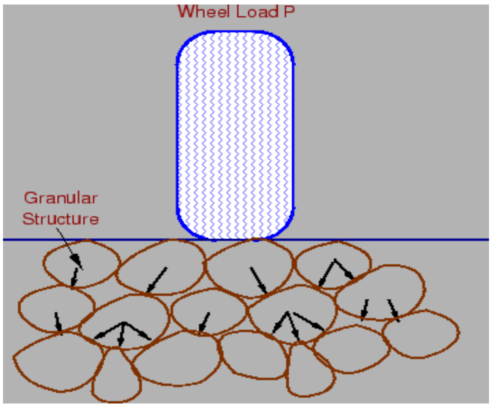

Figure 1.1: Load transfer in granular structure

The wheel load acting on the pavement will be distributed to a wider area, and the stress decreases with the depth. Taking advantage of this stress distribution characteristic, flexible pavements normally has many layers. Hence, the design of flexible pavement uses the concept of layered system. Based on this, flexible pavement may be constructed in a number of layers and the top layer has to be of best quality to sustain maximum compressive stress, in addition to wear and tear. The lower layers will experience lesser magnitude of stress and low-quality material can be used. Flexible pavements are constructed using bituminous materials. These can be either in the form of surface treatments (such as bituminous surface treatments generally found on low volume roads) or, asphalt concrete surface courses (generally used on high volume roads such as national highways). Flexible pavement layers reflect the deformation of the lower layers on to the surface layer (e.g., if there is any undulation in sub-grade then it will be transferred to the surface layer). In the case of flexible pavement, the design is based on overall performance of flexible pavement, and the stresses produced should be kept well below the allowable stresses of each pavement layer.

Singiri Kona Shri Lakshmi Narasimha Swamy Temple is located near Narayanavanam. Our project road is started from Bhimuni Cheruvu, at this point the bench ark is 120m from mean sea level. This road way will cover one village also which is located near Bhimuni Cheruvu. Total road lane from Bhimuni Cheruvu to Singiri Kona is 6 km it is located between to two large hills. At present case maximum road surface is covered with large number of stones and boulders. We are providing single lane pavement with earthen shoulder and drainage

Figure 1.2: Existing Road Surface

2. LITERATURE SURVEY:

Roads are one of the main communication facilities in rural areas. Roads help in the economic upliftment of rural population by providing access to market center and other civic amenities like educational institutions, hospitals, etc. But rural areas in India are lacking adequate road network due to scarcity of funds. Conventional specifications cannot be adopted for rural roads in view of escalating cost for the conventional materials, shortage of manpower, machinery and funds. So, efforts were made at Central Road Research Institute (CRRI) to explore the use of locally available materials as alternate materials for rural road construction. The locally available materials are cheaper, easily available and when suitably processed develop adequate strength. Inspire of their advantages, local materials have not been utilized to their fullest extent.

R. Laxmana Reddy explained in their Designing Pavement for a Typical Village Road in India – A Case Study, The Extension of rural road network is of vital importance for bringing the social amenities, education and health within reasonable reach of villagers/tribal's and for the expeditious transportation of agricultural produce from tribal villages to market yards and distribution centers. There are 72407 habitations in the state of Andhra Pradesh, of which only 41619 habitations are connected by all-weather roads. The total length of road network in the state is about 146944 kms (91307 miles). Of the total road length of 146944 kms, the length of BT road is 8819 kms, WBM is 34226 kms and Gravel road is 60768 kms. There are 6824 unconnected habitations of which 6134 are having a population of 100 and above. The existing soils, climate and terrain conditions in Srikakulam district of Andhra Pradesh state in India are suitable for the development of Agricultural, Sea and Horticulture Products. This paper attempts to address the issues relating to design of such a village road through which the all-round development of the District can be achieved.

S. R. Katkar and P. P. Nagrale explained in their Defining Pavement Condition States to Quantify Road Quality for Designing of Pavement Maintenance Management System Important factor in the Pavement Maintenance Management System (PMMS) is to quantify the quality of pavement. Earlier research is based on various parameters such as pavement condition index (PCI), mechanistic properties, and physical distress. Ultimate objective of Maintenance Management System (MMS) is to optimize the resources required to upgrading that utility. In none of the previous research; the relationship between pavement condition and corresponding maintenance cost has been considered in designing of MMS. In this study, 70 pavements are studied and an attempt is made to categories them in various condition states based on their repair cost. The research is useful in designing of cost-effective MMS.

John Fen, John Bohol, and Curt Sumner explained in their The American Congress on surveying recent changes to the governance structure of ACSM have resulted in some alterations in the character of ACSM's relationship with FIG. This article provides a historical perspective about ACSM, describes the nature of the governance changes and their impact on the ACSM/FIG relationship, and explains that the mission of ACSM remains unchanged.

3. NECESSITY & PRELIMINARY INVESTIGATIONS:

3.1 Engineering Surveys for Road Location:

The following engineering surveys are carried out and finalized the alignment. They are

1. Map study
2. Reconnaissance
3. Preliminary surveys
4. Final location and detailed surveys

3.2 Steps Involved in Surveying:

1. Benchmark
2. Temporary benchmark at regular intervals.
3. Centre line marking
4. Road markings
5. Profile marking (for longitudinal and cross-sectional structures)
6. Establishment of different levels providing gradients as per to design

Figure 3.1: Field Surveying for Taking Levels

3.3 Earth Work Calculations:

The earth work filling and cutting calculated based on the levels taken by the leveling instruments with mid cross-sectional area method

Width of the road way	= 3.75m
Earthen shoulder	= 1m (at each side)
Side slope	= 2 horizonal: 1 vertical
Length of road way	= 5+940 km
Interval	= 20m
Mean depth	= (d1+d2)/2
Central area	= B*D Sqm
Side area	= Sd^2
Total sectional area	= $BD+ Sd^2$
Quantity	= $(BD+ Sd^2)$ *L

3.4 Geotechnical Investigations:

The design and construction of any structure depended on soil characteristics. Soil gives accurate information about the ability of site to support the anticipated loads. In the case of road construction, geotechnical investigations play an important role. The consistency limits are required for soil classification and thickness of pavement depends on soil.

The following experiments are conducted on the soil samples collected and the properties of the soil determined.

i. Sieve Analysis
ii. Liquid limit & Plastic limit

iii. Proctor's compaction test
iv. CBR Test

4. GEOMETRIC DESIGN:

4.1 GENERAL

The geometric design of a high way deals with the dimensions and layout of visible features of the highway such as alignment, sight distances and intersections.

The geometric of highway should be designed to provide optimum efficiency traffic operations with maximum safety at reasonable cost. The designer may be exposed to either planning of new highway network or improvement of existing highways to meet the requirements of the existing and the anticipated traffic.

Geometric design of highways deals with following elements

1. Cross section elements
2. Sight distance considerations
3. Horizontal alignment details
4. Vertical alignment details
5. Intersection elements
6.

Highway geometric is greatly influenced by the topography, locality and traffic characteristics and the requirements of design speed. The factors which control the geometric design requirements are speed, road user and vehicular characteristics, design traffic, traffic capacity and benefit - cost considerations. However, speed is the factor which is important governing most of the geometric design elements of roads.

4.1.1 Pavement surface characteristics

The pavement surface depends on the pavement type which is decided based on the availability of material and funds, volume and composition of traffic, sub -grade and climate conditions, construction facilities and cost considerations. The important surface characteristics of the pavement are the friction, roughness light reflecting characteristics and drainage of surface water. The operating speeds of vehicles are controlled by the pavement surface characteristics.

Even and smooth pavement surfaces permit higher operational speeds; bring down operational cost and enhance comfort and safety. Hence and even and smooth surface is preferred to uneven and rough surfaces for a highway pavement.

Night visibility very much depends upon the light reflecting characteristics of the pavement surface. The glare caused by the reflection of head lights is considerably more on wet pavement surface than on dry pavement. Though light coloured or white pavement surfaces

give good visibility at night, they produce glare and strain on the eye during bright sunlight. Black top pavement surfaces on the other hand provide very poor visibility at nights, especially when the surface is wet.

4.1.2 Highway Cross Section Elements: Cross Slope or Camber

Cross slope or camber is the slope provided to the road surface in the transverse direction to drain off rain water from the road surface. Providing camber is considered important because of two reasons:

1. To prevent the entry of surface water into the sub-grade soil through pavements; the stabi
lity, surface condition and the life of the pavement get adversely affected if the water enters into the sub grade and soil gets soaked.
2. To remove the rain water from the pavement surface as quickly as possible and to allow the pavement to get dry as soon as possible after the rain. The skid resistance of the pavement gets considerably decreased under wet condition, rendering it slippery and unsafe for vehicle operation at high speeds.

Usually the camber is provided on the straight stretchers of roads by raising the center of the carriage way with respect to the edges forming a crown on the center line. The provision of super elevation facilitates the surface drainage at horizontal curves. Camber is generally designated as 1 in 'n' which means that the transverse slope is in the ratio 1 vertical to 'n' horizontal. It is also expressed as a percentage for example x%.

The proposed road approach road is in an area of light to moderate rainfall and suggested a thin bituminous surface with camber of 1 in 50 i.e., 2% for it.

4.1.3 Width of Pavement or Carriage Way

The pavement or carriage way width depends on the width of traffic lane and number of lanes. The lane width is determined on the basis of the width of vehicle and minimum side clearance which may be provided for safety. The number of lanes required in a highway, depends on the predicted traffic volume and the traffic capacity of each lane. The width of pavement is increased, a little, on horizontal curves to take care of centrifugal effect. A single lane of carriage way is of 3.5m (on urban road without kerbs) in accordance with the I.R.C. standards is adopted for the proposed road.

4.1.4 Kerbs

Kerb indicates the boundary between the pavement and the shoulder or sometimes islands or foot - path or kerb parking space. The Krebs is not provided for the proposed road.

4.1.5 Road Margins

The various elements included in the road margins or shoulders, parking lane, frontage road, drive way, cycle track, footpath, guard rail and embankment slope. The details regarding to the provision of road margins is shown in the typical cross section of the proposed road.

4.1.6 Width of Road Way of Formations

Width of formation or road way is the some of the widths of pavement or carriage way including separators if any, and the shoulders. Formation width is the top width of highway embankment or the bottom width of highway cutting excluding the side drain. The formation width of proposed road is taken as 6.75 m.

4.1.7 Right of Way

Right of way is the area of land acquired for the road, along its alignment. The width of this acquired land is known as land width and it depends on the importance of the road and possible future development.

IRC recommends a land width in the range of 12 to 18m for village roads (internal roads) in open areas of plain and rolling terrain. A land width of 12m is proposed for acquisition.

4.1.8 Sight Distance

The safe and efficient operation of vehicle on roads depends among other factors on the road length at which an obstruction, if any becomes visible to the driver in the direction of travel. The feasibility to see ahead, or the visibility is very important for safe vehicle operation in a highway. Sight distance available from a point, is the actual length of road visible a head to the driver at any distance.

The standards for sight distance should satisfy the following three conditions

1. Driver travelling at the design speed has sufficient sight distance or length of road visible a head to stop the vehicle, in case of any obstruction on the road ahead, without collision.
2. Driver travelling at the design speed should be able to safety overtake, at reasonable intervals, the slower vehicles without causing obstruction or hazard to traffic of opposite direction.
3. Driver entering an uncontrolled intersection (particularly un-signalized intersection) has sufficient visibility to enable him to take control of his vehicle and to avoid collision with another vehicle.
4.

The following sight distances are suggested for the proposal road.

1. Stopping Sight Distance (SSD):

The minimum sight distance allowable on a highway at any spot should be of sufficient length to stop a vehicle traveling at design speed safety without collision with any other obstruction.

SSD = lag distance + breaking distance.

Stopping sight distance (SSD):

V = Design Speed in kmph

T = Total reaction time of the driver = 2.5 sec (assume)

2. Overtaking Sight Distance (OSD):

If all the vehicles travel on a road at the design speed, then theoretically there should be on need for any overtaking. In fact, all vehicles do not move at the designed speed and this is particularly true under mixed traffic conditions. In such circumstances, it is necessary for fast moving vehicles to overtake or pass the slow-moving vehicles. It may not be possible to provide the facility to overtake slow moving vehicles throughout the length of a road. In such cases facilities for overtaking slow vehicles with adequate safety should be made possible at frequent distance intervals. IRC recommended for overtaking sight distance is equal to 300m @60 kmph.

4.2 Design Of Horizontal Alignment

The following various design factors are to be considered in the horizontal alignment.

1. Design Speed
2. Radius of Horizontal Curve
3. Super Elevation
4. Widening of pavement
5. Transition curve
6. Compound curve
7. Set back distance
8. Curve resistance

4.2.1 Design Speed

The overall design of geometric of any highway is a function of the design speed. The sight distance, radius of horizontal curve, super elevation extra widening of pavement, length of horizontal transition curve and the length of summit and valley are all dependent on the deign speed.

4.2.2 Radius of Horizontal Curve

Horizontal Curve: A horizontal highway curves are usually employed at the intersection of two straight reaches of an alignment, to facilitate a smooth change in direction, generally circular arcs, combination of circular arcs are used for horizontal curves. There are two curves are designed for the proposed road with same radius. The vehicle moving of a horizontal curve, the centrifugal force acts horizontal outwards through C.G. of the vehicle. The centrifugal force developed depends on the radius of horizontal curves and the speed of the vehicle negotiating on the curve.

Centrifugal Force $P=WV^2/gR$

$$P/W = V^2/gR$$

where
P/W = Impact ratio
P = Centrifugal Force
W = Weight of the Vehicle
V = Speed of Vehicle
g = Acceleration due to gravity
R= radius of the Circular Curve

4.2.3 Super Elevation

When a vehicle negotiating on the horizontal curve, centrifugal force acting outwards from the C.G. of the vehicle. To counteract the effect of centrifugal force and to reduce the tendency of the vehicle to overturn skid, the outer edge of the pavement is raised with respect to the inner edge, thus provided a transverse slope throughout the length of the horizontal curve. The transverse inclination to the pavement is known as super elevation or can't.

4.2.4 Super Elevation Design

The super elevation for 75% of design speed is calculated and neglecting the friction $e = (0.75v)^2/127R$ $e = v^2/225R$ as there is no curve in the alignment. Hence super elevation is not proposed.

4.2.5 Widening of Pavement

On horizontal curves, especially when they are not of very large radii, it is common to widen the pavement slightly more than the normal width. The object of providing extra widening of pavements of horizontal curves is due to the following reasons.

1. The off tracking effects
2. At speed higher than the design speed when the super elevation and lateral friction developed are not fully able to counteract the outwards thrust due to the centrifugal force, some transverse skidding may occur and the rear wheels

may take paths on the outside of those tracked by the front wheels on the horizontal curves. However, this occurs only at excessively high speeds.

3. The path traced by the wheel of a trailer in case of trailer units, is also likely to be on either side of the central path of the towing vehicle, depending on the speed, rigidity of the universal joints and pavement roughens.
4. In order to take curved path with larger radius and to have greater visibility at curve, the drivers have tendency not to follow the central path of the lane, but to use the outer side at the beginning of a curve.

4.3 Typical Cross Section of the Proposed Road:

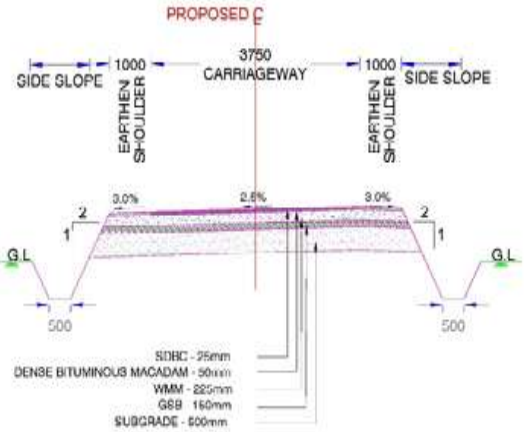

Figure 4.1: Typical Cross -Section

4.4 Excavation of Soil:

The excavation of cutting shall be carried out in accordance with the drawings and to the slopes, levels, depths, widths and heights shown on the drawings. Prior to commencement of works, surveyor will use the survey data of road alignment and TBM provided by the engineer for setting out the extent of cutting in accordance with the cross-sections and put in such pegs, bars, sight rails and reference markers necessary to control the works.

A survey team shall monitor and control each stage of work. All the major setting out works will be carried out jointly with the engineer's surveyor. At the same time, the cut material below the top soil level shall be sampled and tested for laboratory compaction, laboratory CBR, grading and index properties, so that it may be classified as suitable or not for the various categories to fill. Requests for approvals for use of that material as fill will then be submitted.

4.5 Machinery Used:

i. Excavator – J.C.B. or Hitachi EX 100 for bulk excavation, loading on trucks and slope trimming.
ii. Dump truck – For transporting cut materials from the cut area.
iii. Bulldozer – ripping & loosening of earth and rock mixed soil
iv. Grader for trimming to final level and maintaining the surface parallel to the finished line

4.6 Subsoil Work:

This work shall include the supply and installation of subsoil drains constructed in accordance with the contract specification at the locations and in accordance with the lines, levels and grades as shown on the drawings and or as directed by the Engineer.

4.7 Granular Sub Base:

Sub base is the lowest of all the pavement layers consisting of natural sand, mooram, gravel, crushed stone or combination thereof necessary to comply with the grading requirements

4.8 Materials:

Prior to the laying of sub base, a Request for Approval of Material shall be submitted which will indicate compliance with the specified properties of sub base material.

a. Fraction of material passing the 22.4 mm sieve shall have a soaked CBR of 30% or greater.
b. The fraction passing the 0.425 mm sieve shall have Liquid Limit not greater than 25 and a Plasticity Index not greater than 6.
c. The soaked 10% fines value (KN) shall be greater than 50.
d. If the water absorption is greater than 2% the Soundness Test IS 383 shall be carried out.
e. The grading shall be as follows:

4.9 Using Equipment:

The following plants are required for the laying of
a. Motor Grader
b. Tipper Trucks
c. Vibrator Roller
d. Water tank

4.10 Horizontal Alignment Design:

S no	Chainage	Curve side	Radius (m)	Transition Length (m)	Design speed	A	Super elevation Camber
1	0+095.335	Right	50	20	30	1000	7.00%
2	0+145.817	Left	50	15	25	750	5.60%
3	0+261.478	Left	350	0	50	0	3.20%
4	0+398.536	Right	550	0	50	0	2.50%
5	0+491.341	Right	250	15	50	3750	4.40%
6	0+552.589	Right	350	0	50	0	3.20%
7	0+635.416	Left	250	15	50	3750	4.40%
8	0+709.910	Right	100	15	35	1500	5.40%
9	1+060.453	Right	60	15	30	900	6.70%
10	1+139.074	Right	150	15	40	2250	4.70%
11	1+227.033	Left	100	20	40	2000	7.00%
12	1+824.123	Left	150	15	40	2250	4.70%
13	2+187.612	Right	230	15	40	3450	3.10%
14	2+379.123	Left	200	15	40	3000	3.60%
15	2+475.000	Right	60	15	30	900	6.70%
16	2+828.879	Right	200	15	40	3000	3.60%
17	3+169.650	Left	300	15	50	4500	3.70%
18	3+632.041	Left	500	0	50	0	2.50%
19	3+777.577	Right	150	30	50	4500	7.00%
20	4+303.251	Right	200	20	50	4000	5.60%

21	4+481.396	Left	500	0	50	0	2.50%
22	5+172.845	Left	400	15	50	6000	2.80%
23	5+332.615	Right	200	20	50	4000	5.60%
24	5+391.806	Left	200	15	40	3000	3.60%
25	5+516.615	Right	60	15	30	900	6.70%
26	5+544.844	Left	50	25	35	1250	7.00%
27	5+629.822	Right	35	0	20	0	5.10%
28	5+678.989	Left	30	0	20	0	5.90%
29	5+882.658	Left	200	0	30	0	2.50%
30	6+028.649	Right	30	0	20	0	5.90%

5. PROJECT ESTIMATION & COSTING:

Table 5.1: Total project Costs

SINGIRI KONA ROADWAY	
TOTAL PROJECT COST	
DESCRIPTION	**AMOUNT**
Cost of Civil Works	4,62,86,661.39
Add 12% GST	55,54,399.37
Add 1% labour cess	4,62,866.61
Total Project Cost	**5,23,03,927.37**

Table 5.2: Summary of Civil Cost

SINGIRI KONA ROAD WAY (Length = 6 KM)		
SUMMARY OF CIVIL COST		
S No.	**ITEM**	**Amount (Rs)**
1	SITE CLEARENCE	1,78,794.00
2	EARTH WORKS	1,01,17,471.49
3	GRANULAR BASE COURSE AND SUB-BASE	2,07,04,191.00
4	BITUMINOUS COURSES	1,35,28,058.00
5	PIPE CULVERTS	97,800.00
6	DRAINAGE AND PROTECTION WORKS	1,79,625.60
7	TRAFFIC SIGNS	1,56,747.30
8	MISCELLANEOUS ITEMS	15,02,768.00
	Total Cost of Civil works	**4,62,86,661.39**

Table 5.3: Bill of Quantity

SINGIRI KONA ROADWAY					
BILL OF QUANTITIES					
S No.	**Description**	**Unit**	**Qty**	**Rate**	**Amount (Rs.)**
1	**SITE CLEARANCE**				
1.1	Clearing site at light jungle	Sqm	63855	2.80	1,78,794
				Total	**1,78,794**
2	**EARTH WORK**				

2.1	Excavation in Soil using Hydraulic Excavator and Tippers	Cum	22,181	107.00	**23,73,367.00**
2.2	Embankment Construction with Material obtained from Barrow Pits	Cum	-	-	-
2.3	Construction of Subgrade and Earthen Shoulders with approved material obtained from barrow pits with all lifts & leads, transportation to site	Cum	17,078.00	453.46	77,44,104.49
				Total	**1,01,17,471.49**
3	**GRANULAR SUB BASE AND SUBCOARSE**				
3.1	Granular Sub Base with Coarse graded material (Construction of granular sub- base by providing coarse graded material, spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotavator at OMC, and compacting with vibratory roller to achieve the density.	Cum	6,237.00	1,649.62	1,02,88,706.64
3.2	Wet Mix Macadam (Providing, laying, Spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the material with water at OMC in mechanical mix plant carriage of mixed material by tipper to site, laying in uniform layers with paver in sub-base/base course on well prepared surface and compacting with vibratory roller to achieve the desired density.	Cum	5,569.00	1,870.26	1,04,15,484.27
				Total	**2,07,04,191.00**
4	**BITUMINOUS COURSE**				
4.1	prime coat (Providing and applying primer coat with bitumen emulsion on prepared surface of granular base including clearing of road surface and	Sqm	22,275.00	29.40	6,54,938.91
4.2	providing and applying tack coat with bitumen emulsion using emulsion pressure distributor on the prepared bituminous/granular surface				
	(i) On granular surface treated with primer	Sqm	22,275.00	10.13	2,25,737.97
	(ii) On Bituminous surface	Sqm	22,275.00	10.13	2,25,737.97
4.3	Dense Graded Bituminous Macadam (Providing and laying dense bituminous macadam)	Cum	1,114.00	7,370.47	82,10,702.20
4.4	Semi - Dense Bituminous Concrete (Providing and laying semi dense bituminous concrete)	Cum	557.00	7,560.04	42,10,940.50
				Total	**1,35,28,058.00**
5	**DRAINAGE AND PROTECTION WORKS**				
5.1	Excavation for drainage	Cum	2,970.00	60.48	**1,79,625.60**
				Total	**1,79,625.60**

S No.	Description	Unit	Qty	Rate	Amount (Rs.)
6	**TRAFFIC SIGNS**				
6.1	Retro- reflectorized Traffic signs (Providing and fixing of retro- reflectorized cautionary, mandatory and informatory sign as per IRC :67 made of encapsulated lens type reflective sheeting vide clause 801.3, fixed over aluminum sheeting, 1.5 mm thick supported on a mild steel angle iron post 75 mm x 75 mm x 6 mm firmly fixed to the ground by means of properly designed foundation with M15 grade cement concrete 45 cm x 45 cm x 60 cm, 60 cm below ground level as per approved drawing)				
	(i) 90 cm Equilateral triangle	each	30	4,872	1,46,160.00
	(ii) 60 cm Circular	each	1	4,231	4,231.00
	(iii) 60 cm x 60 cm Square	each	1	4,967	4,967.00

6.2	Providing speed breakers across minor roads meeting National Highways and painting with thermoplastic paint as per drawing and MoRT&H	Rm	2	695	1,389.30
				Total	**1,56,747.30**
7	PIPE CULVERT			Total	**97,800.00**
8	**MISCELLANEOUS**				
8.1	Road Marking with Hot Applied Thermoplastic Compound with Reflectorizing Glass Beads on Bituminous Surface (Providing and laying of hot applied thermoplastic compound 2.5 mm thick including reflectorizing glass beads @ 250 gms per sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC:35. The finished surface to be level, uniform and free from streaks and holes.) a) Lane/center line/edge line/ transverse marking	Sqm	1782.00	514.00	915948.00
8.2	Providing and erecting street light mounted on a steel circular hollow pole of standard specifications for street lighting, 9m high spaced 30m apart, 1.8m overhang on one side if fixed on the footpath; fitted with sodium vapor lamp and fixed firmly in concrete foundation.	Nos	13.00	45140.00	586820.00
				Total	**15,02,768.00**
				Total Project Cost	**4,62,86,661.39**

Table 5.4: Detailed Measurement Sheet

			SINGIRI KONA ROAD WAY				
			DETAILED MEASUREMENT SHEET				
S No.	**Description**	**Unit**	**No**	**Length**	**Breadth**	**Depth**	**Quantity**
1	**SITE CLEARANCE**						
1.1	Clearing site at light jungle	Sqm	1	5,940.00	11		63855
					Total		63855
2	**EARTH WORKS**						
2.1	Excavation in Soil using Hydraulic Excavator and Tippers with disposal up to 1000 meters						
	As per Mx calculations						
				22180.84			22180.84
						Say	**22181.000**
2.2	Embankment Construction with Material obtained from Barrow Pits						
	As per Mx calculations						
				0.00			0.000
						Say	**0.000**
2.3	Construction of Subgrade and Earthen Shoulders with approved material obtained from barrow pits with all lifts & leads, transportation to site						
	For Main carriage way						
	TCS	Cum	1.00	5,940.00	3.75	0.50	11137.50
	Earthen Shoulder						
	TCS	Cum	1.00	5,940.00	2.00	0.50	5940.00
						Total	17077.50
						Say	**17078.00**
3	**GRANULAR SUB BASE AND SUBCOARSE**						
3.1	Granular Sub Base with Coarse graded material (Construction of granular sub-base by providing coarse graded material, spreading in uniform layers with motor grader on prepared surface, mixing by mix in						

	place method with rotavator at OMC, and compacting with vibratory roller to achieve the density.						
	For Main carriage way						
	TCS	Cum	1.00	5,940.00	5.00	0.15	4455.00
	Earthen Shoulder						
	TCS	Cum	1.00	5,940.00	2.00	0.15	1782.00
						Total	6237.00
						Say	**6237.00**
3.2	Wet Mix Macadam (Providing, laying, Spreading and compacting graded stone aggregate to wet mix macadam specification including premixing the material with water at OMC in mechanical mix plant carriage of mixed material by tipper to site, laying in uniform layers with paver in sub-base/base course on well prepared surface and compacting with vibratory roller to achieve the desired density.						
	TCS	Cum	1.00	5,940.00	3.75	0.25	5568.75
						Total	5568.75
						Say	**5569.00**
4	**BITUMINOUS COURSE**						
4.1	prime coat (Providing and applying primer coat with bitumen emulsion on prepared surface of granular base including clearing of road surface and spraying primer.						
	TCS	Sqm	1.00	5,940.00	3.75		22275.00
						Total	22275.00
						Say	**22275.00**
4.2	providing and applying tack coat with bitumen emulsion using emulsion pressure distributor on the prepared bituminous/granular surface						
	On granular surface treated with primer						
	TCS	Sqm	1.00	5,940.00	3.75		22275.00
S No.	**Description**	**Unit**	**No**	**Length**	**Breadth**	**Depth**	**Quantity**
						Say	**22275.00**
	On Bituminous surface						
	TCS	Sqm	1.00	5,940.00	3.75		22275.00
						Total	22275.00
						Say	**22275.00**
4.3	Dense Bituminous Macadam						
	TCS	Cum	1.00	5940.0	3.75	0.050	1113.75
						Total	1113.75
						Say	**1114.00**
4.4	Semi-Dense Bituminous Concrete						
	TCS	Cum	1.00	5940.00	3.75	0.025	556.88
						Total	556.88
						Say	**557.00**
5	**DRAINAGE AND PROTECTION WORKS**						
5.1	Excavation for drainage						
	TCS	Cum	1.00	5940.00	0.50	1.00	2970.00
						Total	2970.00
						Say	**2970.00**
6	**TRAFFIC SIGNS**						
6.1	Retro- reflectorized traffic signs (Providing and fixing of retro-reflectorized cautionary, mandatory and informatory sign as per IRC:67)						
	(i) Cautionary signs (90 cm equilateral triangle)	each	30.00				**30.00**

	(ii) Mandatory Signs (60 cm Circular)	each	1.00				**1.00**
	(iii) Informatory (60 x 60 cm Square)	each	1.00				**1.00**
6.2	providing Speed breakers provided at entrance and exit of village						
			2.00	3.75			**7.50**
						Say	**8.00**
7	**MISCELLANEOUS**						
7.1	Road Marking with Hot Applied Thermoplastic Compound with Reflectorizing Glass Beads on Bituminous Surface (Providing and laying of hot applied thermoplastic compound 2.5 mm thick including reflectorizing glass beads @ 250 gms per sqm area, thickness of 2.5 mm is exclusive of surface applied glass beads as per IRC:35. The finished surface to be level, uniform and free from streaks and holes.)						
	Edge line	Sqm	2	5940	0.15		1782
						Total	1782
7.2	Providing and erecting street light mounted on a steel circular hollow pole of standard specifications for street lighting, 9m high spaced 30m apart, 1.8m overhang on one side if fixed on the footpath; fitted with sodium vapor lamp and fixed firmly in concrete foundation.						
	TCS	No	1	500	40m spacing		13

6. Conclusions:

Proposal of Flexible Pavement with economical for Singiri Kona Shri Lakshmi Narasimha Swamy Pilgrimage.

It is very useful for pilgrims and also employees who are working in temple. Up to today the government was not provided roadway for this pilgrimage. So, our project is very useful for the society.

In this project we were done all survey work and Quantity & Estimation of Earthwork, Sub Grade, Granular Sub Base, Wet Mix macadam, Dense Bituminous Concrete, SDBC, Pipe Culvert, traffic Signs & Street lights, also we have done design of horizontal and vertical curves, super elevation, transition curves, drainage, TCS.

The proposed road curves are designed as per existing road levels and its width, because of these we are going to reduce the project cost and also work time.

Each removed soil by cutting shall be used for filling the formation width of the road which will be 5.75 m and side slope shall be 1:2 the carriage way width is provided as 3.75 m and 1.00 m shoulders on either side of carriage way.

Investigation of soil for proposed road side is done. The soil samples are collected from different locations at road site and tested in the laboratory the top wearing coat shall be average thickness of 25mm provided as semi dense bituminous concrete (SDBC) over DBM and WMM (wet mix macadam).

The road designs Plan & Profile, Typical Cross Section and Pipe Culvert are done by using MX Roads and AUTOCAD software's. Also, we took the proposed road levels as per MX Road.

The estimation is carried out by using schedule of rates (SOR) as per economical point of view. The total estimated amount for the proposed road is Rs. 5,23,03,927 /- including GST and labour cess.

References:

1. R. Laxmana Reddy explained in their Designing Pavement for a Typical Village Road in India
2. S. R. Katkar and P. P. Nagrale explained in their Defining Pavement Condition States to Quantify Road Quality for Designing of Pavement Maintenance Management System
3. John Fen, John Bohol, and Curt Sumner explained in their The American Congress on surveying recent changes to the governance structure of ACSM have resulted in some alterations in the character of ACSM's relationship with FIG.
4. J. Selvi explained their Surveying is an interesting subject in Civil Engineering
5. D. R. Cameron, M. Nyberg explained their accuracy of field sampling for soil tests, 10% for N, P and K only 47, 56, and 82 times out of 100, respectively
6. Elizabeth Frink and Daniel Flippo explained their Primitive Geometry Tillage Modeling Tillage practices have a significant effect on soil properties.
7. S.K. KHANNA&C.E. JUSTO Highway Engineering book is explained about all basic concepts of the pavement design.
8. B.N. DUTTA; ESTIMATION AND COSTING is explained about quantity & estimation of earth work and pipe culvert

9. B.C. PUNMIA SURVEYING is explained about road levels with calculation of Hight of Instrument, using of auto level and curve setting.
10. ARORA, SOIL MECHANICS & FOUNDATION ENGINEERING is explained about the soil test and soil types.
11. MORTH 5th edition is explained about the road construction with its specification.
12. IS: 456 and IRC: SP- 13 is explained about pipe culvert design
13. IRC: 37 is explained about the road design of flexible pavement.