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Design and Construction of Rural Road from Boppudi-Kotavaripalem in Andhra Pradesh-A Case Study

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Abstract*— Rural roads can be called as life line of country's development, they provide connectivity to majority population of India living in villages. Construction of rural roads provides not only accessibility to people but also generates increased agricultural productivity, employment as well as non-agricultural productivity, which in turn increases the growth opportunities and income generation of rural population. The rate of industrial development is also based on connectivity in rural areas. And also growing population in rural areas requires proper connectivity to urban areas in order to fulfil their medical and educational needs. The proposed road from Boppudi to Kotavaripalem is located in Chilakaluripeta mandal, Andhra Pradesh, India. It connects three important villages having good agricultural productivity and granite quarries, it also connects these villages to NH5 and nearest town Chilakaluripeta. There by increasing the importance of construction of road both agriculturally and industrially. The road is constructed as a flexible pavement. Design and construction of proposed road based on CBR and CVPD (Commercial Vehicle per Day) for design of sub-grade. The crust consists of 2 layers which are Granular sub-base and Wet-Mix Macadam (WMM). Each layer of crust have been provided by proposed thickness with reference to Rural Roads manual IRC:SP-20:2002 and MORT&H specifications, SDBC (Semi Dense Bituminous Concrete) has been provided up to required thickness.

Keywords*— Rural Road, Granular sub-base, Flexible Pavement, WMM, IRC: SP-20:2002, MORT&H, CBR, CVPD.

I. INTRODUCTION

India has achieved a considerable growth in various fields post-independence, but this growth rate is not satisfactory in rural areas development, this is majorly because of lack of connectivity. Although the 20 year road plans have achieved its targets in connecting major cities by national and state highways. They, to a large extent failed to connect the target number of rural areas, this in turn affecting the life patterns of rural population, and because of which still 40% of rural areas still lack connectivity. Then in addition to this lack of quality control in previously built roads is making the rehabilitation necessary for their proper functioning which is an additional burden. Hence to cope up with all these problems proper construction of rural roads according to specified standards is necessary along with regular maintenance and proper quality control to maintain the longevity of the pavement. The government also understood the importance of rural connectivity and launched programs like Pradhan Mantri Gram Sadak Yojana (PMGSY) and entrusted them in agencies like National Rural Road Development Agency (NRRDA) to efficiently carry out the programme, as a result of which the condition is getting better, the present road under study is also a constructional initiative taken by government to increase rural connectivity.

II. STUDY AREA

Boppudi-Kotavaripalem road is an important and major rural road in Chilakaluripeta mandal of Guntur District .It connects the Chennai-Kolkata Highway at km 359.110. The road passes through important villages namely Boppudi, Kotha Rajapet and Gopalavaripalem .These villages have granite quarries and crushers and abundant agricultural productivity of commercial crops like cotton and tobacco. The road is totally damaged in many portions because of heavy loaded granite carrying vehicles passing through this road. Earlier, repair works were done for this road during 2004-2005 but the condition of the road worsened gradually again causing difficulties for vehicular traffic. Hence reconstruction of the road became essential. In order to bring back the pavement to worthy condition, reconstruction of pavement is proposed from Km 4/0 to 8/0.The construction of this road provides connectivity to 3 villages having overall population of 10,350 people through 2 hospitals, 4 schools, 2 colleges, and an agricultural market yard to the nearest city Chilakaluripeta.

Volume 4 Issue II, February 2016
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The view of the study area is illustrated in Fig. 1 respectively

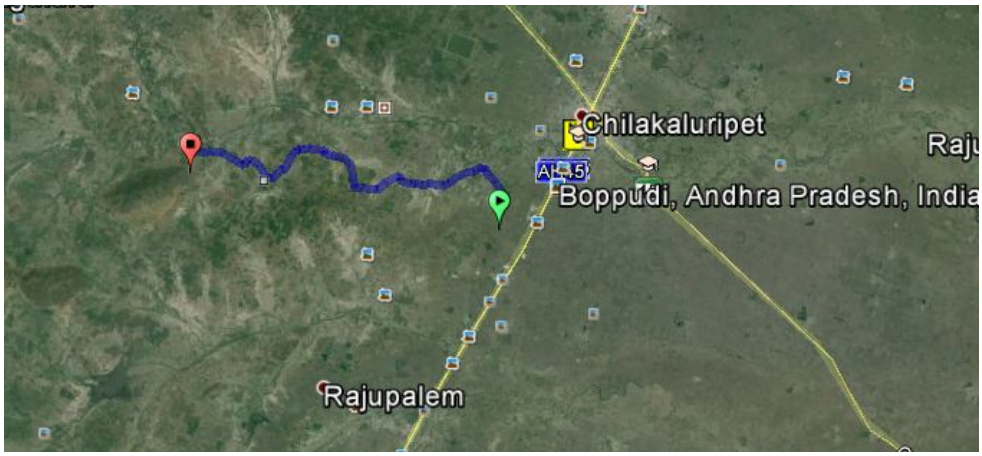

Fig. 1 Map view of proposed road

III. CODES FOLLOWED

The standard codes used during the design and construction process of this Boppudi-Kotavaripalem road is IRC: SP-20:2002 in accordance with MORT&H. The design of rural roads is better done by IRC: SP-20:2002 than IRC 37:2001 because of the feasibility and economical saving it provides and also for the simplicity in design for rural roads. Since the rural roads have specifically different conditions when compared to high volume roads, usage of SP-20:2002 is suggested by NRRDA. The materials used and their standards are also according to above referred codes.

IV. DESIGN PARAMETERS

The current pavement under study is designed as a flexible pavement following IRC: SP-20:2002, the geometric design standards such as design speed, road way width, carriage way width and camber taken in accordance with the site specifications following the chapter 2 of code SP-20:2002 is mentioned in below TABLE.1.

Table.1: Table showing geometric design parameters adapted from IRC: SP-20:2002

Design parameter	Value adapted
Design speed	50kmph
Road way width	7.5m
Carriage way width	3.75m
Shoulder width	1m
Camber	1 in 40 (2.5%)
Side slope	1V:2H

The traffic details of the road and CBR value taken according to field investigation and proceeded to design and proceeded to the construction stage which are discussed below.

V. FIELD INVESTIGATION AND DATA COLLECTION

Necessary field investigations are carried out to find out the budget estimate of the work, traffic details in terms of commercial vehicles per day (CVPD), soil investigations were also performed to find out the CBR values of the site before proceeding to the design.

A. Cost Estimate Of Project

The overall project construction cost is worked out to be 76 lakhs INR, which includes rates of all construction materials, transportation charges, labour wages, seigniorage charges, taxing and other miscellaneous expenses also.

B. Soil Investigation And CBR Determination

The soil investigations such as determination of Maximum Dry Density (MDD), Optimum Moisture Content (OMC) are performed confining to the code IS: 2720 (Part-VII)-1980 and CBR according to IS: 2720 (Part-XVI). Subgrade strength determined according to 4 day soaked CBR value, After several laboratory investigations the CBR value at 2.5 is attained as 4% and CBR value at 5.0 is attained as 3.8%,since CBR 2.5>CBR 5 the value of CBR is adapted as 4% for the design process.

C. Traffic Survey

Traffic volume studies were also conducted at the proposed road site to determine the current traffic details and proceed to design ,the count was clinical in estimating Commercial Vehicle Per Day (CVPD) which includes vehicles whose laden weight (>3T). A 3 day 16 hour count was conducted following PGMSY guidelines and present CVPD determined and projected CVPD is estimated. The results are tabulated as follows in Table. 2

Table.2: Table showing present and projected CVPD from traffic census IRC: SP-20:2002

S.no	From	To	Length (Km)	Present CVPD	Projected CVPD
1	Boppudi	Kotavaripalem	4	198	354

D. Profile Survey Of Site And Alignment Of Road

Land profile survey was carried out by two types of sections namely longitudinal section and cross section and necessary corrections are made to profile before star of the work. Levelling operation is performed to determine the amount of cut and fill and necessary adjustments are made to create a balanced profile. The alignment of road here need not be fixed newly because of the pre-existence of the path.

VI. DESIGN ACCORDING TO IRC-SP-20:2000

The design is performed according to rural roads code considering the traffic in accordance with Equivalent Single axle load (ESAL) (8.16tonnes) application during the design life 10 years, various others parameters considered for the design and design process is discussed below.

Initial traffic in terms of CVPD

Traffic growth rate during design period

Design life in number of years

Then based on above data design traffic (A) is calculated according to following formulae and thickness of pavement determined by using standard chart given in code corresponding to specific CBR value attained

Design traffic (A) = $P(1+r)^{n+x}$ A= Number of CVPD for design

$=198(1+0.06)^{10}$ P= CVPD at last count = 198 according to survey

$=198(1.06)^{10}$ r= Traffic growth rate = 6%according to code

$=198(1.7908)$ n= Years b/w traffic count and completion of construction = 0years

$=354$ CVPD x= Design life = 10 years

Now based on the design traffic 354 CVPD and CBR value of 4% the thickness of pavement attained from below Fig. 2

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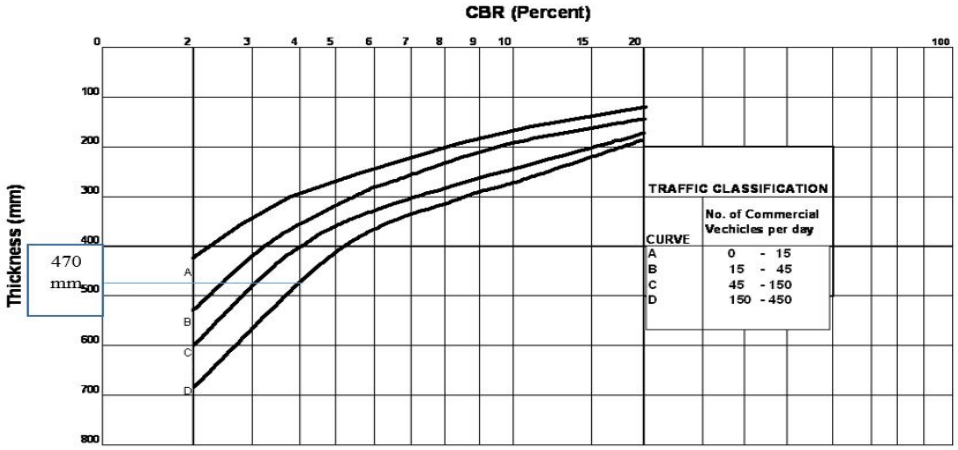

Fig. 2 Design chart according to code IRC-SP: 20-2002

Now from the design chart according to the code the total thickness of the pavement is attained as 470mm, further this thickness can be sub divided into sub layers following the design catalogue specified in the code for specific CBR value and CVPD details. For design traffic of 384 CVPD and CBR value of 4%, the thickness of 470 mm can be divided into sub layers following the design catalogue as follows from Fig. 3

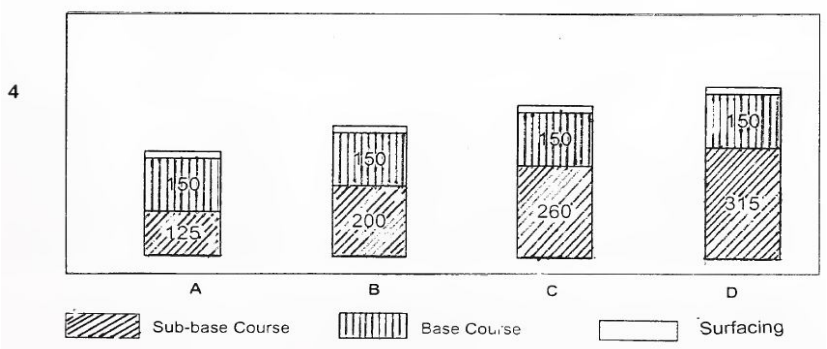

Fig. 3 Thickness design catalogue IRC-SP: 20-2002

After making necessary adjustments to work with ease in the field, the four layers of the pavement subgrade, sub base, base and wearing course are provided with following specifications given in TABLE.3.

Table.3: Table showing thickness details of individual layers

Total thickness = 450mm (excluding prepared subgrade)		
Layer of Pavement	Provision made	Thickness(mm)
Subgrade	Existing natural subgrade compacted to OMC	-
Sub-base	Granular Sub Base (GSB)	300
Base	Wet Mix Macadam (WMM)	150
Wearing course/Surface course	SDBC	20

According to the above procedure pavement design and thickness calculations of individual layers are made and proceeded to the construction stage.

VII. CROSS-SECTIONAL VIEW OF DESIGNED PAVEMENT

Before going in detailed into the construction procedure adapted, the overall cross sectional view of pavement designed so far incorporating all features of geometric design and pavement layer thickness is demonstrated in Fig.4

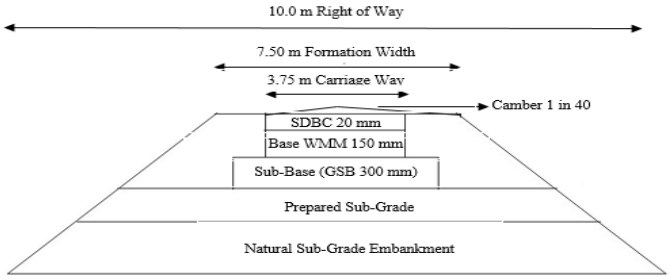

Fig. 4 Cross sectional view of designed pavement

VIII. FIELD CONSTRUCTION PROCESS ADAPTED IN PROJECT SITE

After concluding the design process and attaining necessary information from it, the work is progressed to the construction stage. The various construction methodologies adapted and specifications followed for the construction of flexible pavement from Boppudi-Kotavaripalem is presented stage wise.

A. Subgrade Preparation

The construction of subgrade is done according to following procedure on site following codal specifications
The existing soil in the site is scarified to a depth of 300 mm and cleared properly
Any debris or undesirable matter are removed
Weak sections are reinforced with suitable stabilization processes
The subgrade compacted to 98% dry density following IS 2720 (Part-XVI)
The subgrade is prepared according to the procedure mentioned above and proceeded to sub base construction.

B. Sub-Base Construction

The sub-base or Granular Sub-Base (GSB) is constructed according to the detailing given below following codal specifications
The total thickness attained for GSB during design process 300 mm is constructed in two layers of 150 mm each to achieve proper compaction of granular material
Rock boulders size ranging from 45-90 mm used for this process (IRC-SP20:2002)
They are laid on site and rolled in two layers by watering regularly
A smooth wheeled roller is used to complete this operation
Compaction of 95% is achieved according to codal specifications
The sub base is constructed according to procedure mentioned above and following codal specifications

C. Base Course Preparation

The base course is constructed as Wet Mix Macadam (WMM). The total thickness of base course attained according to design is 150 mm, this is constructed in two layers of 75 mm each to achieve proper compaction. The first layer of WMM is laid and spread manually and rolled whereas second layer is completed my mechanical means.
The specifications followed for construction of WMM is confined to clause 406 of MORT&H
95-98% of compaction is achieved by watering and rolling necessarily
During mechanical means of construction a mechanical paver is used to attain good finish and uniform thickness
The plates of paver can be adjusted based on camber provision
Vibratory drum roller is used for rolling operation
The aggregate constituents of WMM is specified below in Table. 4

Volume 4 Issue II, February 2016
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Table.4: Aggregate proportions of WMM

Size of aggregate	% by weight of mix
40 mm HBG	26
20 mm HBG	23
10mm HBG	10
6 mm HBG	22
Dust HBG	19

*HBG=Hand Broken Grade

The aggregates used are previously subjected to necessary testing and checked their engineering properties are within range according to code IS: 2386-1963, on site construction of WMM is illustrated in Fig. 5 and Fig. 6 below

Fig. 5 WMM laying by paver & author checking thickness

Fig. 6 WMM rolling by vibratory drum roller

D. Prime Coating

Before the construction of surface course prime coat and tack coat application is done on prepared WMM at site. The laying of prime coat is done in following steps

Prime coat is generally applied with bituminous emulsion (Bitumen+ Water+ emulsifier (anionic/cationic)

Emulsifier manufactured at high temperatures and can be used at low temperatures

It is prepared as slurry and applied

On site application is done by usage of sprinkler

Prime coat is applied for major purpose of dust proofing and water proofing

Prime coat is laid in this manner following codal and contract specifications

E. Tack Coating

After construction of prime coat, a tack coat is applied on it which tacks the surface layer with bottom layer. The procedure adapted on site for tack coating is mentioned below.

Tack coat is laid on prime coat after it i.e. dried

High viscosity of tack layer will result in high pavement strength

Dilute slow set emulsions with bitumen grade 80/100 is used in this project

Tack coat laying is completed in this procedure and proceeded to surface layer construction

F. Surface Course/Wearing Course Construction

The thickness of surface course attained according to design is 20mm. A Semi Dense Bituminous Concrete layer is provided as surface course in this project confining to following specifications

SDBC is prepared in hot mix plant nearby site at temperature 170-190^{0}c.

Bitumen grade of 60/70 is used in this project
SDBC laid by mechanical means to achieve uniform thickness
98-100% compaction is achieved necessarily by rolling
The constituents of SDBC are specified in below tabular form Table. 5

Table.4: Aggregate proportions of SDBC

Size of aggregate	% by weight of mix
10 mm HBG	37
6 mm HBG	32
Dust	25
Lime	2
Bitumen 60/70	5

*HBG=Hand Broken Grade

G. Shoulder Construction

After construction of surface course the pavement is left still for some days. Then before opening to traffic shoulder construction is done forming right of way. This shoulder construction is done by using gravel and rolling up to 98% compaction and finished to grade. Then the constructed road from Boppudi-Kotavaripalem is opened to traffic.

H. Quality Control

Necessary quality control inspections are performed by collecting core samples from the field and all the results are found to be satisfactory.

IX. CONCLUSIONS

The following conclusions can be made from this case study of rural road construction from Boppudi-Kotavaripalem and the below suggestions made to improve the transit conditions of the pavement based on observations
Converting of the existing single lane into double lane road in future is essential to cope up with growing commercial traffic of the region.
Proper and regular maintenance of the pavement is essential for functioning up to design life
An alternate route should be made for granite carrying vehicles to enter NH5 which reduces loading impact on current road
Periodical inspections should be made to check condition of newly constructed pavement
The study helped in comprehensive understanding and design of pavement according to rural road specifications
Hence the flexible pavement from Boppudi-Kotavaripalem constructed successfully following rural road specifications and opened for regular traffic usage within duration of two months.

X. ACKNOWLEDGMENT

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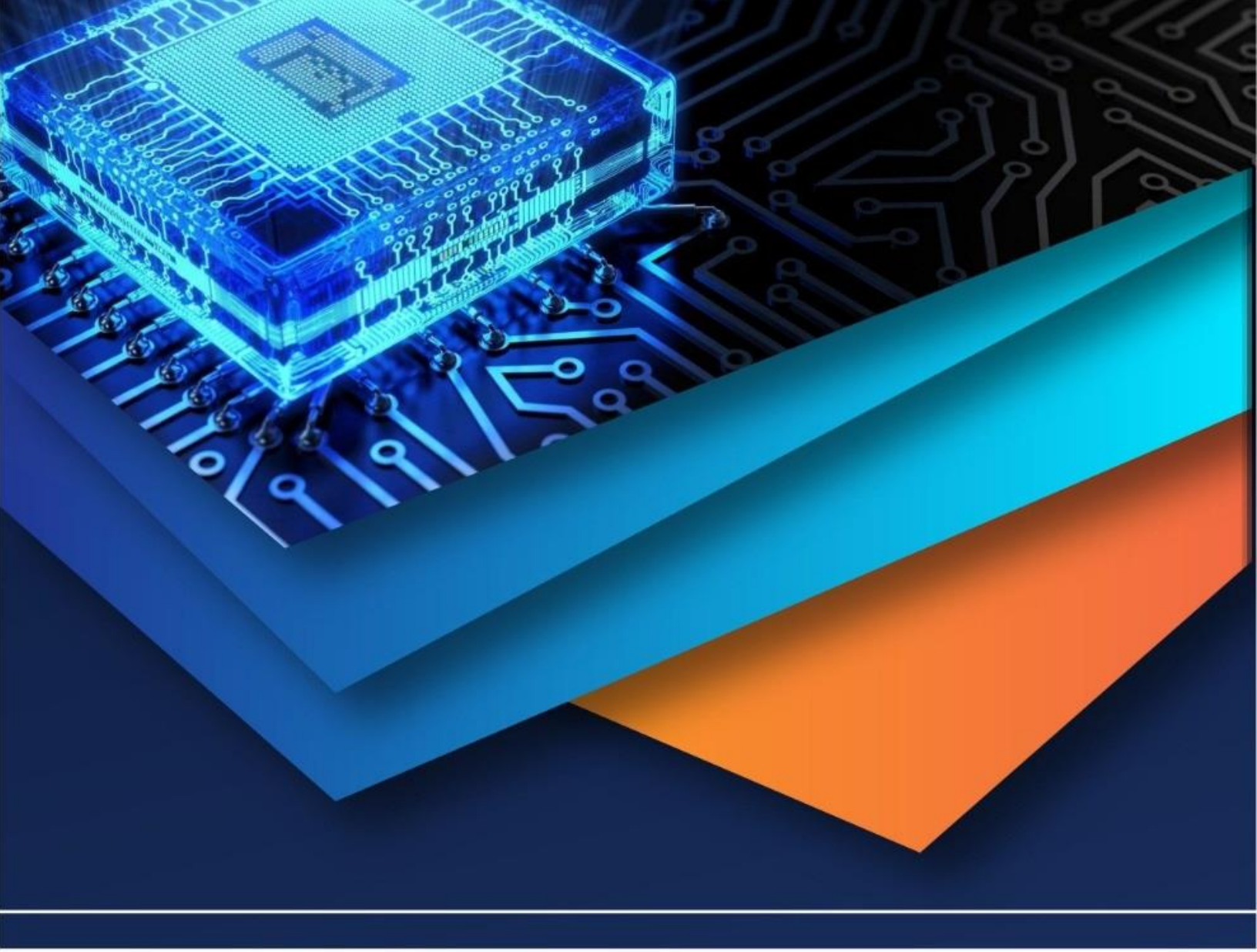
REFERENCES

[1] Rural Roads Manual, IRC: SP: 20-2002.
[2] S. K. Khanna and C. E. G. Justo, Highway Engineering, Nemchand and Brothers, 2012.
[3] L. R. Kadiyali, Traffic Engineering and Transportation Panning, Khanna publications, 2012.
[4] Guidelines for Design of Flexible Pavements, IRC:37-2001
[5] Specifications for Road and Bridge Works, MORT&H Fourth Revision, Indian Road Congress, New Delhi, India, 2001.
[6] Method of Test for Soils, IS: 2720 (Part- VII) (Part- XVI), 1980.
[7] Methods of Test for Aggregates, IS: 2386, 1963.
[8] Manual for Survey, Investigation and preparation of Road Projects,IRC:SP:19-2001
[9] Amish das, S. K. Mohanty, K. S. Reddy and B.S. Pandey "Analytical Design Criteria for Village Roads in India" Transportation Research Record,1652,76-81.



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