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Detailed Project Report of Designing a Flexible Pavement Including Cross Drainage Work of a Village Road near Suburb of Bhubaneswar, India

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ABSTRACT: A detailed project report (DPR) of 1.45Km is prepared for a proposed village road to be constructed on an earthen road connecting Niranjanpur village to Sundarpada-Jatni Main Road. This will help in providing all-weather connectivity to the people residing in the nearby villages. The existing earthen road is of very low quality with undulations and depression all along. The road passes through laterite quarries and rain fed forest. During rainy season, most part of the road remains muddy and some parts are submerged in rain water due to poor drainage system. This proposal is to provide a flexible pavement for the entire length of this earthen road connected with a drainage system for a stretch of 400m. A slab culvert is also designed for the project road having a span of 3m as per the requirements. This paper includes all the parts regarding soil and material testing, pavement designs, drainage and culvert designs including drawings and estimations.

Keywords: Detailed project report (DPR), Major district road (MDR), Culvert, Cross Drainage, Embankment

ORIGINAL ARTICLE

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INTRODUCTION

A 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 (Adeyeri Joseph, 2014; Saurabh et al., 2013). Development of rural roads brings multiple socio-economic benefits to the rural areas which form a strong base of the local economy in particular and national economy at large. It is also a key ingredient in ensuring poverty reduction. The primary benefits are increased mobility, increased productivity, transportation cost saving, flow of commodities visa-vis changing the life style of the inhabitants. Rural road connectivity is a key component of rural development by promoting access to services thereby increasing agricultural income and productive employment opportunities ensuring poverty reduction (PMGSY, 2017). Several programs for development of rural roads have been initiated in India but still the goal seems to be far away from reality. This road belongs to Jatni block. The road is situated near the Orissa Engineering College, Bhubaneswar campus connecting the Sundarpada-Jatani road to Niranjanpur village situated at a distance of 60kms from coastline of Bay of Bengal. The total length of the road is 1.45km. During rainy season, most of the parts of the road remain muddy and some parts are submerged in rain water due to insufficient drainage system for mountain water. After completion of this project it will facilitate all weather connectivity for the inhabitants of nearby villages. The general climatic condition of the area is neither very hot nor extremely cold with temperature varying between 9^0C to 45^0C in winter and summer respectively. The annual average rainfall of the locality is 1443mm though humidity ranges up to 95% during post monsoon.

Reconnaissance survey

This road connects the Sundarpada-Jatani road and NIranjanpur village. There is an existing slab culvert at chainage 0.000km at the road junction. Main gate of Orissa Engineering College is situated at chainage 0.200km, three shops at 0.250km, a post office, a bank and police outpost at chainage 0.450km. Most of the areas in the left side of the road are quarry areas and rock mines. There is a place surrounded by trees at chainage

0.900km to 1.450km, a culvert at a chainage 0.974km. There exist two curves at chainage 0.800km and 1.200km, a temple beside the road at chainage 1.340km finally connecting Niranjanpur-Jamukoli road at chainage 1.450km.

Carriage way width: The proposed road is an intermediate carriage way with paved shoulders. The pavement width will be 5.5m and the total formation width will be 10.5m including shoulders.

Surfacing type: The existing pavement is earthen for the entire road stretch. The new road will have flexible pavement. All the culverts in the project road are carried over by same flexible bituminous surfacing of the road.

Embankment height: It varies from 1.5m to 2m. However, high embankment exists along significant length of the project road. The condition of the embankment is fair.

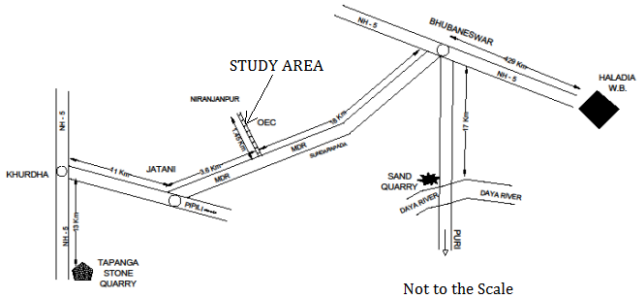


Figure 1. Study area of the proposed road

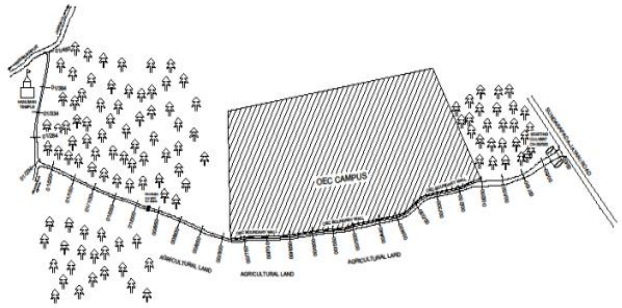
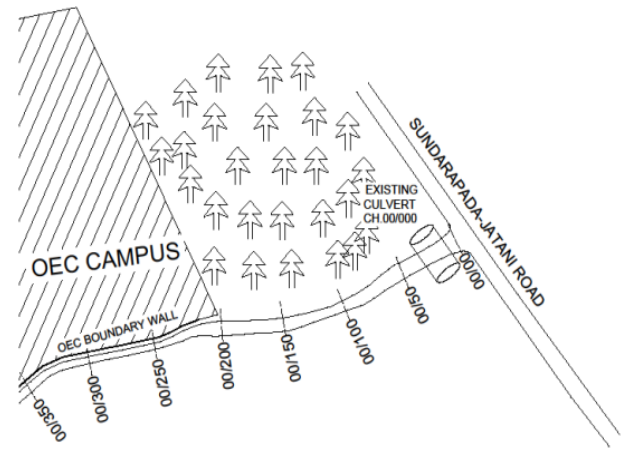


Figure 2. Existing road in the study area



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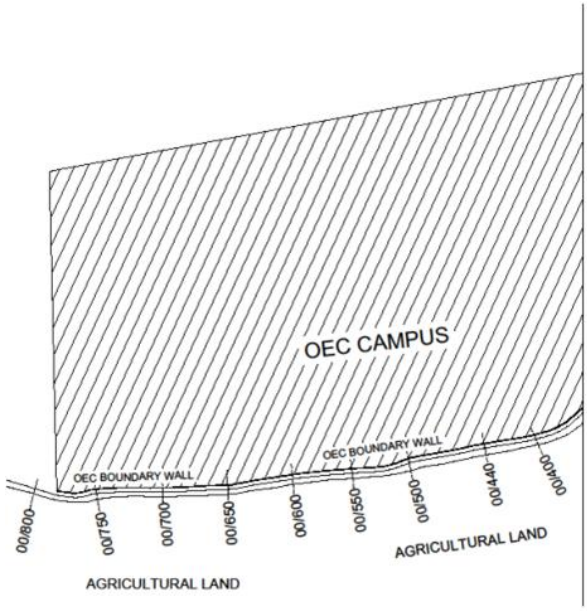

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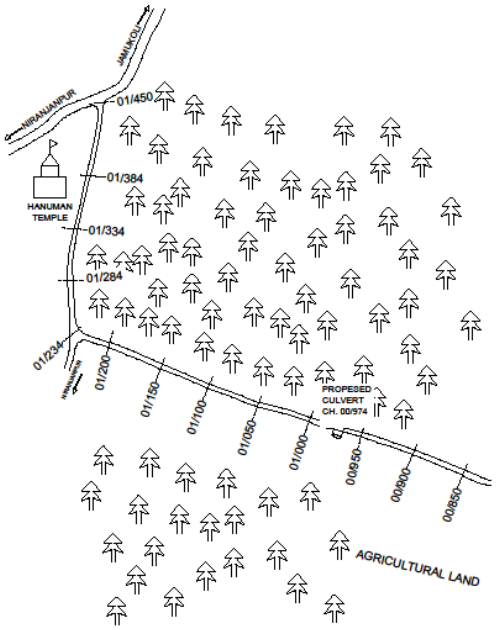

C

Figure 3. Reconnaissance survey of the proposed road (A, B, C)

Traffic Survey

General: Traffic counts are to be taken into account in the vicinity of the project road to provide a realistic result. In the Present scenario of new connectivity/up gradation road 7 days @ 15 hours/day traffic volume count has been conducted on the already completed MDR connecting from Sundarpada to Jatani Road in the vicinity of the project road. The classified Volume Count survey has been carried out in accordance with the requirements of the TOR and relevant codes (IRC: SP:19-2001, IRC: SP:20, IRC: SP:72-2007).

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Traffic Data and Analysis

The traffic count done was classified into different vehicle category as given below:

- Motorized vehicle comprising of light commercial vehicle, medium commercial vehicle, heavy commercial vehicle, trucks, buses, agricultural tractors with trailers, jeep, two wheelers etc. in the 1st week of September 2017 starting from Monday.
- Non-motorized vehicles comprising of cycle, rickshaw, cycle van, animal drawn vehicle etc. in the 2nd week of September 2017 starting from Monday. Traffic volume count for this project road was done during 2nd week of September. Average of 7 day traffic data is presented in Table 1.

Traffic Growth rate and forecast

In the absence of any specific information to the designer, an average annual growth rate 7.5% over the design life has been adopted (IRC:SP:72-2007). The growth rate of 7.5% seems reasonable depending on socio economic considerations and future growth on account of generated and diverted traffic on this road. The details of traffic survey are as follows:

Table 1. Average daily traffic volume

Days	Bicycle	2wheeler	3Wheeler	Carts	4Wheeler	6Wheeler	10Wheeler
Monday	43	164	23	0	42	85	1
Tuesday	38	136	27	0	33	84	0
Wednesday	33	126	17	3	44	86	2
Thursday	46	150	22	2	39	84	1
Friday	39	98	25	2	34	82	1
Saturday	35	112	18	6	46	82	2
Sunday	40	78	20	4	34	76	4

Soils and Materials Survey

General: The soil and material investigations were done following the guidelines of IRC:SP:20-2002 and IRC:SP:72-2007 and other relevant IS codes. The potential sources of borrow areas for soil and quarry sites has been identified.

Soil sample collection and Testing:

Soil samples are collected along and around the road alignment at three Locations per km, from the adjoining borrow areas, as well as one sample is collected from the existing road. Soil classification tests like grain size analysis and Atterberg's limit were conducted for all the samples collected. Standard proctor test and the corresponding 4 day soaked CBR test were conducted for 3 tests per km for soil sample due to variation of soil type. The following tests were conducted as detailed below:

- Grain size distribution as per IS:2720 (part 4)-1985
- Atterberg's limit as per IS:2720 (part-5)-1985
- 4 day soaked CBR test as per IS:2720 (part-7)-1980
- Optimum moisture content as per IS:2720 (part-8)-1983
- Dry density as per IS:2720 (part-29)-1975
- Specific gravity as per IS:2386 (part-3)-1963

Analysis of Test Results:

The detailed test results for the above mentioned laboratory measures have been presented in Table 2.

Tests of coarse and fine aggregates

Information regarding the source of aggregates and sand has been gathered. The stone aggregates are to be procured from Tapanga whereas locally available sand from river Daya shall be used. The source and the lead distance from the quarry to project site have been finalized. The aggregates and sand where ever available and acceptable are to be used for bituminous work, concrete works, other pavement works. The different test results of the aggregates and bitumen are presented in Table 3 and Table 4 respectively.

Table 2. Soil Analysis report

Serial no.	Tests	Results
1	Grain size distribution	Well graded
2	Plastic limit	24.9%
3	Liquid limit	18%
4	CBR Test	8%
5	OMC	9%
6	Dry density	2.1kg/m^3
7	Specific gravity	2.5

Table 3. Aggregate results

Serial No.	Tests	Results
1	Grading of aggregates	Confirmed as per specification
2	Impact test	24.07%
3	Crushing strength test	24.36%
4	Abrasion test	0.8%
5	Flakiness test	14.36%
6	Elongation test	11.22%
7	Grading of fine aggregates	Zone 3

Table 4. Results of bitumen tests

Serial No.	Tests	Results
1	Penetration test	100mm
2	Ductility test	80mm
3	Softening point test	49°c

HYDROLOGICAL SURVEY

General: Hydrological survey is necessary for design of adequate and safe Cross Drainage Structures so that the rain water can pass as per natural slope. Hydrological survey of the proposed road is based on the following observations:

a. Rainfall Data
b. Catchments Area
c. Time of Concentration
d. Existing Cross Drainage Structures

Rainfall Data

Rainfall Data as applicable for the project road were collected with maximum rainfall occurring in the months of July, August and September. It was found to be 1443mm per annum.

Catchment Area

The catchments area is calculated by gathering local information and topographical survey data as Well as from topographical sheets.

Time of Concentration

Time of concentration (tc) in hours is calculated from the formula of $(0.89 \times L^3/H)^{0.385}$, where L is the distance from the critical point to the structure site in km and H is the difference in elevation between the critical point and the structure site in meters.

Quantity of Runoff

Drainage area consist of

i) Pavement area = 2.75 X 200 = 500m^2 {A_1 with C_1=0.8}

ii) Area of shoulder with adjoining land = 170 X 200=34000 m^2 {A_2 with C_2=0.4}

Total drainage area = $\mathbf{A_1 + A_2}$

= 550 + 34000 = 34550

A_d = 34.55m^2

Runoff co-efficient

$C = A_1 C_1 + A_2 C_2 / A_1 + A_2$

= 550 X 0.8 + 34000 X 0.4/550 + 34000 = 0.40m

The maximum distance of flow across the land up to longitudinal drain is = 170m and the slope is 2.9%, therefore inlet time T_1

$$T_1 = \{0.89L^3/H\}^{0.385}$$

L = Distance from the critical point to site of drain = 0.7km

H = Fall in elevation from the critical point to site of drain = 5m

$T_1 = \{0.89 \text{ X } 0.7^3 /5\}^{0.385} = \{0.89 \text{ X } 0.343 /5\}^{0.385} = \{0.30527 /5\}^{0.385} = \{0.061054\}^{0.385} = 0.3408 \text{ X } 60 = 20.448 \approx 20$min

Time flow T_2 along longitudinal drain of length 200m on gravely soil with a speed of 0.8m/s (assumed) = 200/0.8 X 60 = 200/48 = 4.166 ≈ 4min

Total duration of rainfall = $T_1 + T_2$ = 20 + 4 = 24min

i= 185/60 X 60 = 185/3600 = 0.05138 ≈ 0.0514 m/s

Discharge

(Q) = CiA_d

= 0.4 X 0.05148 X 34.55 = 0.710348m^3/s

Cross section

Area of cross section of flow in drain is given by

A= Q / V

= 0.710348/0.8 = 0.887935m^2

Assuming bottom width = 0.6 (Figure.6)

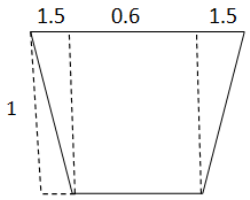

Figure 6. Cross section of drainage

Slope of vertical 1 to 1.5 horizontal to width = (0.6 + 3D) m

Area of cross section of drain is given by = 0.887 = (0.6 + 0.6 + 3d) X d/2

0.887 = (1.2 + 3d) X d/2

0.887 = 1.2d/2 + 3d^2/2

0.887 = 1.2d + 3d^2/2

3d^2 + 1.2d - 1.774 = 0

Solve this equation by $\mathbf{d} = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$ where; a = 3, b = 1.2, c = - 1.774

By solving d = 0.59m

Therefore the average depth of drain may between as o.7m after allowing free board.

7 X 1.5 = 1.05

Slope of drain

When the depth of flow in the trapezoidal drain is 0.59m the slope slides of the trapezium is equal to 0.7m

Wetted perimeter = 0.6 + 1 + 1 = 2.6 m

R = hydraulic perimeter

R = 0.59/2.6 = 0.226m

By manning formula

$V = R^{2/3} \text{ X } S^{1/2}/N$

$S^{1/2} = V \text{ X } N/R^{2/3}$

$S^{1/2} = 0.8 \text{ X } 0.025/0.226^{2/3}$

$S = (0.053)^2$, S = 0.0029 or 1:345

CROSS DRAINAGE DESIGN

Whenever highway crosses a river or stream, cross drainage works have to be provided. Sometimes water

from side drains also is diverted away from the road through cross drains to divert water from the road to a water course. On highways usually culverts and bridges are used as cross water way of about 6 m, and then the cross drainage structure is known as culvert. For higher discharge and greater linear way the structure is known as bridge (Khedia, 2016).

CULVERT DESIGN

Determination of Design Discharge

The maximum discharge which a culvert across a natural stream is to be designed to pass can be estimated by the following method:

a) Empirical formula
b) Rational Formula
c) Area velocity method

A) Empirical formula:

From Ryve's formula: $Q = CA^{2/3}$

Q = maximum flood discharge in m^3/sec

A = Catchment area in km^2 = 1.58km^2

C = 8.5 for area between 25 and 160km from the coast

$Q = 8.5 \times A^{2/3} = 8.5 \times 1.58^{2/3} = 11.5 m^3/sec$

B) Rational Formula:

$Q = Al_0\lambda$

$\lambda = \frac{0.56PF}{t_c + 1}$

$t_c = [\frac{0.89 \times L^3}{H}]^{0.385}$

Data:

l_0 = Peak intensity of rainfall in mm/hour = 46 (For Bhubaneswar)

F = 1.0 (factor to correct the intensity of rainfall)

P = 0.5 (percentage co-efficient of run-off)

A = 1.58Km^2 (catchment area)

L = 1.5Km (distance from the critical point to the culvert site in km)

H = 5m (difference in elevation between the critical point and culvert site in meter)

$t_c = [\frac{0.89 \times (1.5)^3}{5}]^{0.385}$ = 0.821 (concentration time in hours)

$\lambda = \frac{0.56 \times 0.5 \times 1.0}{0.821 + 1} = 0.153$

$Q = 1.58 \times 46 \times 0.153 = 11.12\ m^3/sec$

C) Velocity – Area Method:

A = Wetted area in m^2 = 4.37m^2

P = Wetted perimeter in m = 5.69m

(Taking coefficient of roughness η = 0.03)

S = Slope of stream = $\frac{1}{100}$

R = Hydraulic mean depth

$= A/P = \frac{4.37}{5.69} = 0.76$

Velocity, $V = \frac{1}{n} \times R^{0.67} \times S^{0.5} = \frac{1}{0.03} \times (0.76)^{0.67} \times (0.01)^{0.5}$ = 2.77m/sec

Discharge, Q = AV

$= 4.37 \times 2.77 = 12.12 m^3/sec$

Since the values obtained from the three methods are reasonably close to each other the maximum of the three values is adopted for design.

Design discharge = 12.12m^3/sec

Discharge carrying capacity of culvert using Manning's formula:

Assuming span = 3m, height = 2m and free board = 0.3m

Q = AV

Q = Discharge through culvert in m^3/sec

A = Cross section area of culvert in m^2

V = velocity in m/sec

$\mathbf{V} = \frac{(R^{2/3} \times S^{1/2})}{n}$

A = Wetted area

$= 3 \times 1.7 = 5.1 m^2$

P = Wetted perimeter

$= 3 + (2 \times 1.7) = 6.4$m

R = Hydraulic mean depth

$= A/P = \frac{5.1}{6.4} = 0.796$

S = Slope of the bed adopted = $1/1000 = 0.001$

η = Rigidity co-efficient for concrete base on cement finishing = 0.012

Velocity, $V = \frac{(R^{2/3} \times S^{1/2})}{n} = \{\frac{(0.796)^{2/3} \times (0.001)^{1/2})}{0.012}\}$ = 2.63 m/sec

$Q = A \times V$

$= 5.1 \times 2.63 = 13.413 m^3/sec$

Note: Discharge carrying capacity of the culvert is more than the required design discharge. Hence, the design is safe.

SLAB CULVERT

Assuming, Span = 3.0m; Height = 2.0m; providing free board of 0.3m

Design of slab:

For concrete slab

Clear span = 3m

Clear width of roadway = 5.5m

Thickness of wearing coat = 75mm

Width of support = 400mm

Using M_{20} grade concrete is Fe_{415} steel

Assume thickness of slab culvert as 400mm and effective cover as 50mm (Figure.7)

D = 400mm – 50mm = 350mm

Effective span = 3 + 0.35 = 3.35m

Dead load:

Dead load of slab = 0.4 × 25 = 1kN/m^2

Dead load of wearing coat = 0.075 X 22 =1.65

Total load = 11.65kN/m^2

Bending moment due to dead load = $\frac{wl^2}{8}$ = $\frac{11.65 \times 3.35^2}{8}$ = 16.34kNm (per m width of slab)

Position or live load to give maximum bending moment:

Total width of culvert = 5.5 + (2 X 2.5) = 10.5m

Assume 2.5m shoulder both side

Width of single lunch carriage way culvert = 3.8m

For additional lane 3m is added

Two lane culvert = 3.8 + 3 = 6.8m<10.5m since width of culvert is 10.5m. So it is a two lane culvert.

Minimum clear distance between two vehicle = 0.4m to 1.2m for carriage way width of 5.5m to7.5m

For 5.5m width clear distance between two vehicle = 0.4

Width of contact area of wheel = 500mm = 0.5m

Distance between two vehicle = 0.4 + 0.5 = 0.9m = 1m

Assuming distance of wheel from C = 150mm = 0.15m

Distance of centre of wheel from kerb = 0.15 + $\frac{0.5}{2}$ = 0.4m

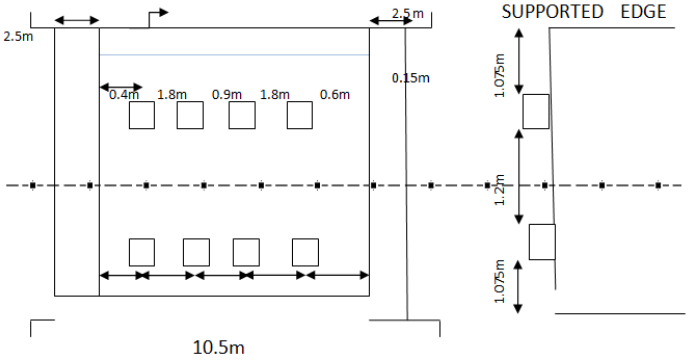

Figure 7. Position of Wheel Loads

Figure 7 shows the position of the various wheels of the vehicle which will give maximum bending moment. For class-A loading, the heaviest load is 11.4tones or 114kN which is to be placed near the centre of the span to give maximum time.

Calculation of effective width:

$b_{ef\,f}$ = k.x ((1-$\frac{x}{leff}$)+a_0)

L_{eff}=3.35m

K = 3.48 (From table)

The breadth of each track after 45^0 depression through wearing coat

a_0 = 0.5 + 2 X 0.075 = 0.65 m

x = $\frac{Leff}{2}$ = $\frac{3.35}{2}$ = 1.675 m

{b_{eff} = 2.48 X 1.675 X (1- $\frac{1.675}{3.35}$) + 0.6} = 2.231m

It can be seen that the effective width for the heavy wheels overlaps. Hence all the four heavy wheels are to be considered together acting over the effective width.

Load per unit width of slab = $\frac{2 \text{ x } 114}{10.5}$ = 21.71kN

Depressed length for the wheel load along the span = Tyres contact length + 2 (thickness of wearing coat + thickness of slab = 250 + 2 X (400 X 75) = 1200mm = 12m

The position of load for the maximum bending moment calculation is (Figure 8).

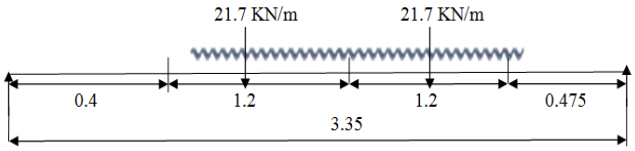

Figure 8. Position of load for the maximum bending moment

$R_A = R_B = \frac{Total\ load}{2} = \frac{2 \text{ x } 21.7}{2}$ = 21.7kN

Load per 'm' run: $\frac{21.7}{1.2}$ = 18.08kN/m

Maximum bending moment at centre of span = 21.7 X $\frac{3.35}{2}$ - 18.08 X $\frac{1.2^2}{2}$ = 23.33kNm

Impact factor for class A wheel loading = $\frac{4.5}{6+L_{eff}}$ = $\frac{4.5}{6+3.35}$ = 0.48

Maximum bending moment due to live load including the impact effect = 1.4 X 23.33

= 32.662kNm

Total bending moment = 16.34 + 32.662 = 49kNm

Check for depth:

M_u = 0.138 f_{ck} bd^2

d = $\sqrt{\frac{49 \times 10^6}{0.138 \times 20 \times 1000}}$ = 133.24 < 350mm

Area of steel calculation:

M_u = 0.87 F_y A_{steel} d (1 - $\frac{A_{steel}\,F_y}{bdF_{ck}}$) = 49 X 10^6 = 0.87 X 415 X A_{steel} X 350 (1- $\frac{A_{steel} \times 415}{20 \times 1000 \times 350}$)

A_{steel} = 397.10mm^2

Provide 20mm dia. bar

$Ast_{provide}$ = 314 X 2 = 628mm^2

Minimum steel = $\frac{0.12}{100}$ X 1000 X 400 = 480mm^2 < $Ast_{provide}$

Distribution bar:

As per IRC:6:2016, Distribution bar is the slab culvert is provided to resin a moment = sum of 0.2 times

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the dead load moment and 0.3 times live load moment including the impact effect.

Moment in transverse distribution = 0.2 x 16.34 + 0.3 x 32.66 = 13.06kN/m

Effective depth in transverse distribution (Assume 12mm dia. to be used) = 400 – 50 - 10 – 6 = 334 mm

Area of steel calculation:

$M_u = 0.87\ F_y\ A_{steel}\ d\ (1 - \frac{A_{steel}\ F_y}{bdF_{ck}})$

$13.06 \times 10^6 = 0.87 \times 415 \times A_{steel} \times 334\ (1 - \frac{A_{steel} \times 415}{20 \times 1000 \times 334})$

$A_{steel\ Req.} = 109mm^2$

Again, $A_{steel\ min.} = \frac{0.12}{100} \times 1000 \times 400 = 480mm$

Provide 10mm dia. distribution bars

Spacing

Spacing for main reinforcement should be minimum of following:

1. $\frac{314}{628} \times 1000 = 500mm$
2. 0.75 X 400 = 300mm
3. 300mm

Providing 20mm dia. bar as main reinforcement @300mm c/c.

Spacing for distribution reinforcement should be minimum of following:

1. $\frac{78}{480} \times 1000 = 162mm$
2. 0.5×400 = 200mm
3. 450mm

Providing 10mm dia. bar as distribution reinforcement @160mm c/c (Figure 9 and Figure 10).

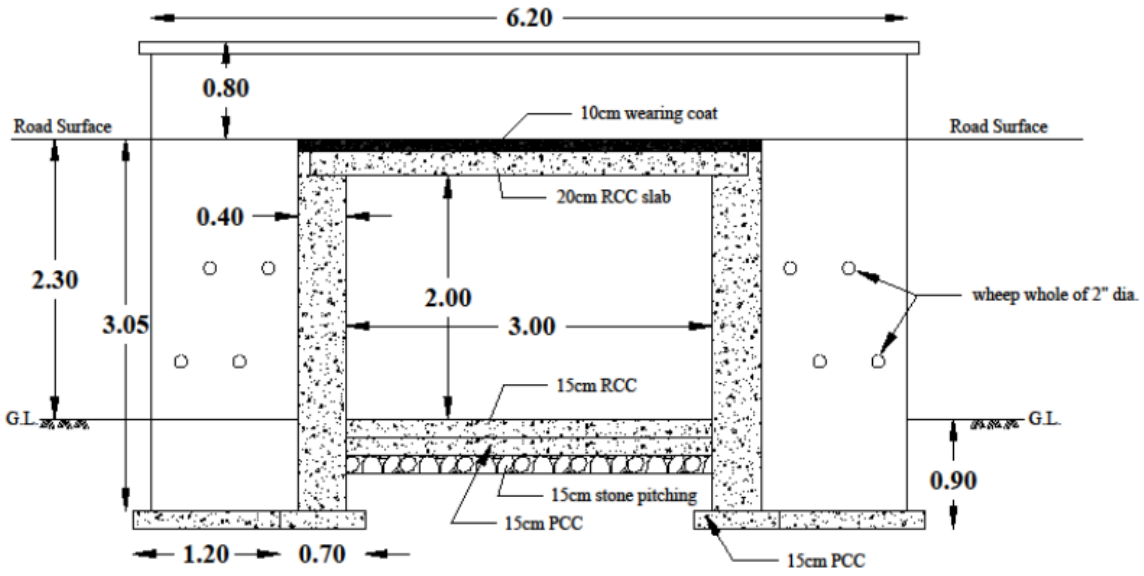

Figure 9. Sectional view of the culvert

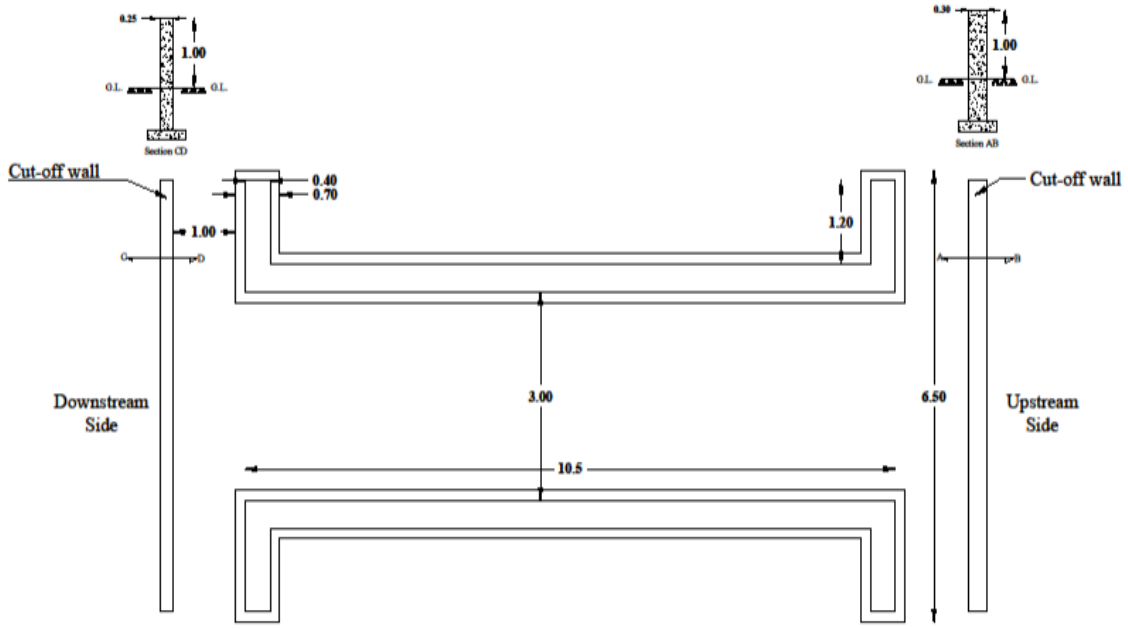

Figure 10. Plan view of the culvert

SPECIFICATIONS

General: The 'specification for Rural Roads' published by IRC on behalf of the Ministry of Rural Development, Govt. of India has been followed.

Construction Equipment

Construction by manual means and simple tools has been considered for the project as per the guideline of NRRDA, 2015 for handling of bulk materials like spreading of aggregates in sub-base and base courses by mix-in-place method, use of motor grader and tractor-towed rotavator has been allowed in line with the schedule of rate for PMGSY, 2017 work. Compaction of all items shall be done by ordinary smooth wheeled roller if the thickness of the compacted layer does not exceed 100 mm. It is also considered that, hot mix plant of medium type and capacity with separate dryer arrangement for aggregate shall be used for bituminous surfacing work that can be easily shifted. A self-propelled or towed bitumen pressure sprayer shall be used for spraying the materials in narrow strips with a pressure hand sprayer. Now the vibratory rollers are also being used for rapid progress.

For structural works, concrete shall be mixed in a mechanical mixer fitted with water measuring device. The excavation shall be done manually or mechanically using suitable medium size excavators.

Construction Methods

Preparation for Earthwork: After setting out existing ground shall be scarified to a minimum depth of 150mm and levelled manually and compacted with ordinary roller to receive the first layer of earthwork. In filling area, existing embankment will be generally widened on both sides as per the alignment plan. Continuous horizontal bench, each at least 300 mm wide, shall be cut on the existing slopes for bonding with the fresh embankment/sub grade material as per CI 301.7.

Embankment work

Material from borrow pits will be used for embankment construction as well as the approved material deposited at site from road way cutting and excavation of drain and foundation may be used. Layer of the earth shall be laid in not more than 25cm (loose) thick layers and each compacted layer of the soil up to 30cm below the sub grade level at OMC to meet 97% of Standard Proctor Density.

Sub-grade

Material from borrow pits will be used for construction of top 30cm as sub-grade. Soil in these sections is quite good for road construction. Top 30cm up to the sub grade level and shoulder at OMC to meet 100% of Standard Proctor Density by proper control of moisture and by required compaction with a smooth wheeled roller.

Sub-base

Sub base material in the form of stone aggregates and sand as available in the area to be used in GSB Grade III layer.

Base

Stone aggregates will be used in base course. 63mm to 45mm size (Grading 2) aggregate has been proposed for the bottom layer and 53mm to 22.4mm (Grading 3) size has been proposed for the top layer.

Shoulder

Earthen shoulder shall be constructed in layers and compacted to 100% of Proctor's Density. First layer of shoulder shall be laid after the sub-base layer is laid. Thereafter earth layer shall be laid with base layer of pavement and compacted.

Surfacing

Slow setting bitumen emulsion will be applied as primer on Water Bound Macadam (WBM) layer. Emulsion shall be sprayed on surface with pressure distributor. Rapid setting bituminous emulsion shall be used for tack coat. Premixed carpet and mixed with equivalent viscosity grade bitumen shall be laid as surfacing course. 6 mm thick type C seal coat is considered for sealing of the premixed carpet.

Structural Works

Following grades of concrete are proposed for Structural works and comply with MORD and IRC specifications (Figure.11):

- Concrete in superstructure of slab culvert: M_{25} (RCC)
- Concrete in abutment, return wall, headwall: M_{15} (PCC)
- Concrete below abutment, return wall, headwall: M_{15} (PCC)
- Concrete in Rigid Pavement: M_{30} (PCC)

Estimate and Costing

The detailed estimation and costing of the road and culvert are presented in Table 5 and Table 6.

Table 5. Estimate and costing of Road work

Sl No	Description	No	L	B	H	QNTY	Unit	Rate	Amount
1	Earth Work in excavation in hard soil within initial leads and lifts including dressing and levelling of bed etc. complete.								
a	abutment	2	10.8	0.7	3.2	48.384			
b	Wing wall	4	1.2	0.7	3.2	10.752			
c	cut-off wall	2	6.8	0.6	0.75	6.12			
d	Bed flooring								
i	In between abutments	1	10.5	3	0.45	14.175			
ii	between wing wall and cut-off wall	2	6.8	1	0.45	6.12			
					Total	**85.551**	**CuM**	**99.89**	**8545.60**
2	Filling foundation with sand including watering and ramming with cost, conveyance, royalty of sand and labour charges etc. complete.								
a	abutment	2	10.8	0.7	0.15	2.268			
b	Wing wall	4	1.2	0.7	0.15	0.504			
c	cut-off wall	2	6.8	0.6	0.15	1.224			
					Total	**3.996**	**CuM**	**395.79**	**1581.56**
3	P.C.C.(1:3:6) in foundation and plinth using 40mm size b.h.g.c.b metal including mixing of materials and laying in well prepared surface and compacting, watering curing with cost, conveyance, royalties of all materials, T and P and Labour charges etc. complete.								
a	abutment	2	10.8	0.7	0.15	2.268			
b	Wing wall	4	1.2	0.7	0.15	0.504			
c	cut-off wall	2	6.8	0.6	0.15	1.224			
d	Bed flooring								
i	In between abutments	1	10.5	3	0.15	4.725			
ii	between wing wall and cut-off wall	2	6.8	1	0.15	2.04			
					Total	**8.721**	**CuM**	**4116.99**	**35904.27**
4	RCC M-25 in Box Wall.								
a	Abutment	2	10.5	0.4	2.95	24.78			
	Deduct 30cm bearing of deck slab	2	10.5	0.3	0.2	1.26			
					Total	**23.52**	**CuM**	**6500.74**	**152897.38**
5	RCC M-25 in Wing Wall.	4	1.2	0.4	2.95	5.664	CuM	6947.27	39349.36
6	RCC M-25 in cut-off wall.								
a	Upstream side	1	6.5	0.3	1.6	3.12			
b	Downstream side	1	6.5	0.2	1.6	2.08			
					Total	**5.2**	**CuM**	**6500.74**	**33803.84**
7	RCC M-25 in Deck Slab with Centering and Shuttering	1	10.5	3.2	0.2	6.72	CuM	6623.88	44512.45
8	RCC M-25 in Foundation Raft								
a	Bed flooring in between abutments	1	10.5	3	0.15	4.725			
b	bed flooring between wing wall and cut0off wall	2	6.5	1	0.15	1.95			
					Total	**6.675**	**CuM**	**5653.17**	**37734.93**
9	Providing HYSD reinforcement for RCC works including bending, binding and placing in position as per Drawing including cost, conveyance of all materials, all labour and T and P etc. complete.	Volume of steel = 0.037478 CuM Density of steel = 7580Kg/CuM Weight of Steel = 294Kg adding 5% for bending and cutting				3.08	Quintal	5827.51	17948.72
10	Skin reinforcement for abutment					1.9	Quintal	5827.51	11072.26
11	Providing fitting and fixing weep wholes including all cost and taxes etc. complete.	50	0.4			20	Meter	102.00	2040.00
12	shuttering and centering	2	26.6		3.2	85.12	SqM	373.11	31759.12
13	Providing filter media with 40-90mm stone aggregate and sand etc. complete	2.00	12.10	0.30	2.95	21.417	CuM	1654.80	35440.85
14	wearing coat over slab	1	3.8	10.5	0.1	3.99	CuM	6623.88	26429.27
15	Providing and laying random rubble hard granite stone flooring embedded with PCC M-15 Grade as per Section 2500 of MoSRT and H specifications for Road and Bridge works (Latest Revision)								
a	In between abutments	1	10.5	3	0.15	4.725	CuM	3517.28	16619.17
b	between wing wall and cut-off wall	2	6.5	1	0.15	1.95	CuM	3517.28	6858.70
16	RCC M25 parapet wall	2	6.2	0.3	0.8	2.976	CuM	6947.27	20675.09
								Total	**523172.57**

Table 6. Estimate and costing of Cross drainage work

SL NO	Description	No	L	B	H	QNTY	Unit	Rate	Amount in INR
1	Cleaning and grubbing road land including uprooting rank vegetation, grass, bushes, shrubs, sapling and trees girth up to 300mm, removal of stumps of trees cut earlier and disposal of unserviceable materials and stacking of serviceable materials to be used or auctioned, up to lead of 1000m including removal and disposal of top organic soil not exceeding 150mm in thickness. (in area of light jungle)	2	1450	2.25	Not Required	6525	SqM	3.67	23955.79
2	Earth Work excavation in hard soil within initial leads and lifts including complete dressing and levelling of bed etc.	Volume of earth work = volume of earth work as per section sheet - total crust volume=462767.5-3628.625=459138.87 cum				11796.95	CuM	50.00	589847.50
3	Providing and laying Granular Sub Base with Close Graded Grading-II materials as per table 400-1,spreading in uniform layers with motor grader on prepared surface, mixing by mix in place method with rotator at OMC and compacting with VRR to achieve desired density as per Clause 401of MoRT and H specifications for Road and Bridge Works (4th Revision).	1	1450	5.5	0.15	1196.25	CuM	1336.80	1599145.83
4	Providing, Laying, spreading and compacting graded stone aggregate up to W.M.M. specifications including premixing material with water at OMC in mechanical mix plant and 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 VRR to achieve the desired density as per Clause 406 of MoRT and H specifications for Road and Bridge Work (4th Revision).	1	1450	5.5	0.235	1874.125	CuM	1531.66	2870527.66
5	Providing and Applying Primer Coat with bitumen emulsion on prepared surface of granular base including cleaning the road surface and spreading primer @ 0.60kg per SqM using mechanical means as per Clause 502 of MoRT and H specifications for Road and Bridge Works (4th Revision).	1	1450	5.5	Not Required	7975	SqM	30.79	245567.57
6	Providing and Applying Tack coat with bitumen 60/70 Grade using emulsion pressure distributor @ 0.20kg / SqM on the prepared bituminous/granular surface cleaned with mechanical broom as per Clause 503 of MoRT and H specifications for Road and Bridge Works (4th Revision).	1	1450	5.5	Not Required	7975	SqM	10.40	82935.61
7	Providing and Laying Bituminous Macadam with Hot Mix Plant using crushed aggregates of grading-II materials, premixed with bituminous binder, transported to site, laid over previously prepared surface with paver finisher to the required grade level and alignment and rolled to achieve desired compaction as per clause-504 of MoRT and H specification for Road and Bridge Works (4th Revision).	1	1450	5.5	0.05	398.75	CuM	6817.76	2718579.97
8	Providing and Laying Semi dense Bituminous Concrete with Hot Mix Plant using crushed aggregates of grading-II materials, premixed with bituminous binder, transported to site, laid over previously prepared surface with paver finisher to required grade level and alignment and rolled to achieve desired compaction as per clause-508 of MoRT and H specification for Road and Bridge Works (4th Revision).	1	1450	5.5	0.025	199.375	CuM	9164.16	1827105.32
9	Fine dressing and turfing the slopes of embankment with compact turf grass with as per approved drawing and technical specifications as per clause 307 of MoSRTand H Specifications for	2	1450	2.25	Not Required	6525	SqM	14.14	92276.68
10	Providing and laying surface dressing using crushed stone aggregates of 13mm nominal size and 60/70 penetration grade of bitumen as per clause 510 of MoSRTand H specifications for road and Bridge works (Latest Revision)	1	1450	5.5	Not Required	7975	SqM	80.88	645020.90
								Total	**10694962.82**

CONCLUSION

The connecting road designed and estimated at a least price providing the localized materials for the subgrade which is moorum in nature. From the traffic volume survey the commercial vehicle per day has been obtained (93 CVPD). This tends to conclude that there is need for improvement of lane width. Based on CBR value obtained the thickness of pavement has to be increased as the existing thickness of pavement do not cater to the volume count of vehicles. It is the detail project report of the road connecting from Sundarpada-Jatni road to Niranjanpur of 1.45Km. Two culverts and a 400m drainage system are designed as per the requirement. The estimate cost for the project was found to be nearly 1.12Cr. Most important part to conclude that a safe and durable road with two culverts have been designed taking all the technical specifications into consideration strictly adhering to the Indian Standard Code of practices.

Author's Contributions

All authors contributed equally to this work.

Competing interest

The authors declare that they have no competing interests.

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