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Optimization of Structure to Achieve Economy in Transportation

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Abstract: ***KALESHWARAM Project (Dr. B.R.A. Pranahitha Chevella Sujala Sravanthi Project), comprises of 28 packages. This Road Bridge under consideration is selected from package 15 of this project. The Kaleshwaram project main canal on its way is crossing the existing road at chainage K.M 6.740. The proposed road bridge is intended to establish Connectivity between TEEGUL Village and RAMNAGAR Village by crossing kaleshwaram Project main canal at KM.6.740. The existing road is a B T Road for which a Single lane Road bridge is proposed.***

A Single lane road bridge is that permits two-way traffic in a single lane width. This kind of roads was common in rural areas. This structure has to be inevitably provide across this irrigation canal to establish the connectivity.

As the irrigation canal crossing BT road along the proposed alignment the government of Telangana proposed a Double Lane Road Bridge. Instead, proposal of a single lane road bridge was examined in the place of Double Lane Road Bridge on the basis of traffic study at the site of the structure.

Before the proposal of Single Lane Road Bridge, soil Investigation was done at the proposed site to arrive the soil characteristics. Traffic survey was conducted for the road at the proposed site of the structure. The data thus obtained lead to the choice of a single lane road bridge.

The Single lane road bridge thus proposed was designed in the light of the relevant IRC & IS codes. Its estimate is arrived to be 0.36 Crores and the Double lane Road bridge is of 0.83 Crores as per department estimate.

Thus by optimizing and adopting a Single Lane Road Bridge over a Double Lane Road Bridge, economy in the cost of structure will be achieved.

Keywords: Road Bridge, Traffic Survey, Economy.

1. INTRODUTION

A bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for road, a railway, pedestrian etc. the obstacle may be a river, a road, railway or a valley.

Since time immemorial humankind has looked for ways and means to build economical bridges. There has been advancement in the techniques associated with bridge construction over the ages. Different types of bridge have evolved over a period of time.

Bridges are classified by their purpose or functions, such as

- Road bridges
- Railway bridges
- Aqueducts
- Viaducts
- Foot bridges

A typical bridge consists of two parts the superstructure and substructure. The super structure is the deck slab portion where the vehicles are moving and substructure on the other hand is the piers with a foundation at the base.

In superstructure different types are being preferred according to the span and loading namely

- Girders bridges
- T- beam bridges
- Deck slab bridges etc.

In the beginning bridges were very simple structures that were built from easily accessible natural resources- wooden logs, stone and dirt. Because of that, they had ability only to span very close distances, and their structural integrity was not high because mortar was not yet invented and rain slowly but constantly dissolved dirt fillings of the bridge. Revolution in the bridge construction came in Ancient Rome whose engineers found that grinded out volcanic rocks can serve as an excellent material for making mortar. This invention enabled them to build much more sturdier, powerful and larger structures than any civilization before them. Seeing the power of roads and connections to distant lands, Roman architects soon spread across the Europe, Africa and Asia, building bridges and roads of very high quality. Bridge history is filled with incredible achievements and new technologies that enabled bridges to become one of the most important tools of bridging cities, countries and continents.
Modern bridges are usually made with the combination of concrete, irons and cables, and can be built from very small sizes to incredible lengths that span entire mountains, rough landscapes, lakes and seas.

1.1 OBJECTIVES OF THE STUDY

The Main objectives of this project is to propose an economical structure by reducing the initial construction cost and maintenance cost of the structure and provide connectivity between two villages.

- Achieving the economy in transportation by reducing the cost of the project
- Reducing the maintenance cost of the structures
- Providing the connectivity between the two villages
- Satisfying or Improving the capacity of the road bridge by optimizing the structure
- Promote and sustain the agricultural growth
- Enhance democratic processes and bring people into mainstream
- Quick completion of project
- Improving the rural development

2. METHODOLOGY

Scope of this project is achieving the economy in transportation by optimizing the Structure. In this project Geo-technical survey and Traffic survey was carried out for knowing the feasibility of structure to be proposed either a double lane road bridge or Single lane road bridge. The output data from survey is taken and designed a Single lane road bridge then drawings are prepared by using AutoCAD software. Detailed estimation shows economy of transportation.

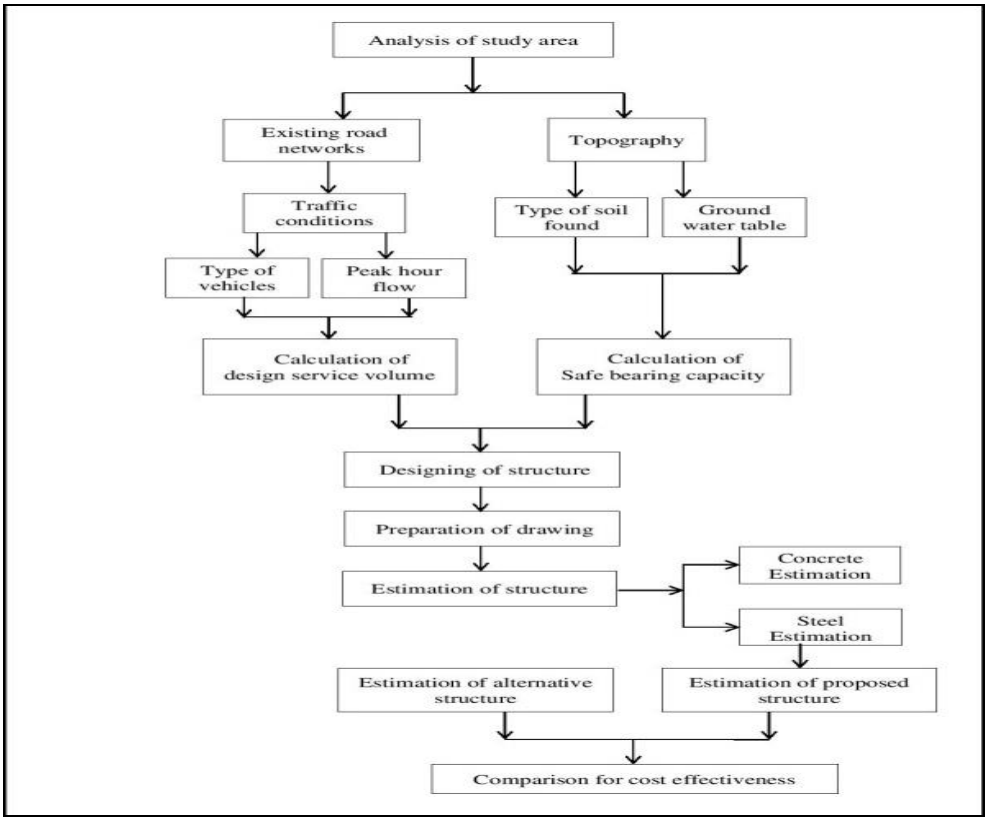

Fig. 1: Flow chart showing methodology for Optimization of Structure to Achieve Economy in Transportation

3. STUDY AREA AND DATA COLLECTION

3.1 STUDY AREA

Jagdevpur mandal in Medak district was taken as Study area where this structure needs to be constructed. The proposed bridge is connecting two villages which are

- TEEGUL
- RAMNAGAR

TEEGUL: Teegul is the main village in Jagdevpur mandal, Medak District of Telangana, India. Total area of Teegul is 3559 hectares. According to census information the total population of Teegul is 4271 living in 996 houses, among them male population is 2137 and female population is 2134. It has an average elevation of 393 meters above sea level.
Teegul is surrounded by Gajwel Mandal towards west, Wargal Mandal towards west, Mulug Mandal towards west, Rajapet Mandal towards East.

Agriculture information:
Cotton, Maize, Chilli, Ground Nut, Paddy, Wheat, Sugarcane, Turmeric, Pulses are the major crops that are cultivated mostly in this area.

RAM NAGAR: Ram nagar is one the main village in Jagdevpur mandal, Medak District of Telangana, India. Total area of Ram nagar is 3559 hectares. According to census information the total population of Ram nagar is 671 living in 143 houses, among them male population is 335 and female population is 336. It has an average elevation of 275 meters above sea level.
Ram nagar is surrounded by Gajwel Mandal towards west, Wargal Mandal towards west, Mulug Mandal towards west, Rajapet Mandal towards East.

Agriculture information
Cotton, Maize, Chilli, Ground Nut, Paddy, Wheat, Sugarcane, Turmeric, Pulses are the major crops that are cultivated mostly in this area.

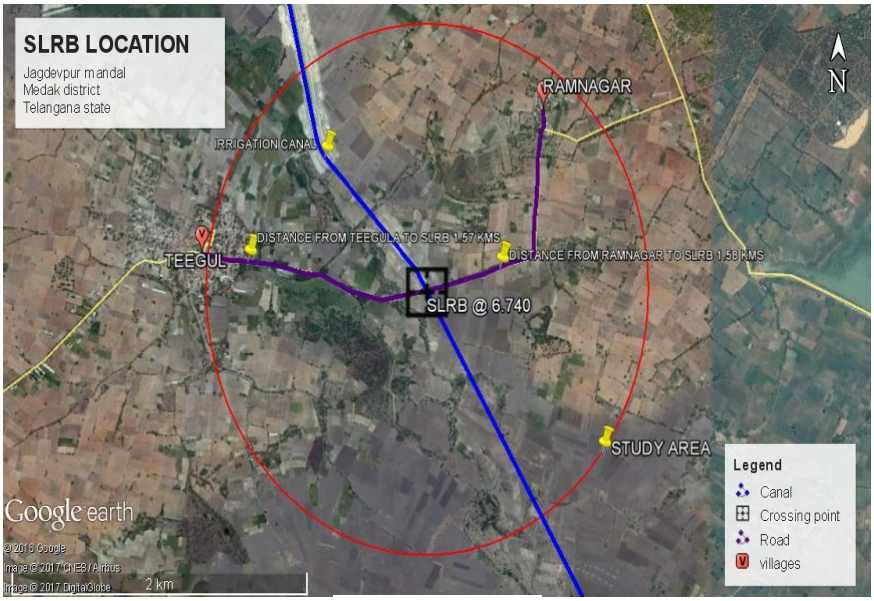

Fig. 2: Study area map

4. TRAFFIC SURVEY

Traffic Count by Manual Method:
Traffic volume studies are conducted to determine the number, movements, and classifications of roadway vehicles at a given location. These data can help identify critical flow time periods, determine the influence of large vehicles or pedestrians on vehicular traffic flow, or document traffic volume trends. The length of the sampling period depends on the type of count being taken and the intended use of the data recorded.

4.1 Manual Count Recording Methods

Manual counts are recorded using one of three methods: tally sheets, mechanical counting boards, or electronic counting boards.
Tally Sheets
Recording data into tally sheets is the simplest means of conducting manual counts. The data can be recorded with a tick mark on a pre-prepared field form. A watch or stopwatch is necessary to measure the desired count interval.
Key Steps to a Manual Count Study
1. Perform necessary office preparations.

2. Select proper observer location.
3. Label data sheets and record observations.

4.2 Objectives of Traffic Survey

The primary objective of these traffic studies is:

1. To determine characteristics of traffic movement and to establish base year traffic demand on the proposed bridge link connecting Teegul to Ramnagar village in Medak district
2. To calculate the traffic projections and propose configuration of bridge based on Capacity calculations
3. To determine loading pattern
4. To design the deck slab of the road.
5. To design intersection.

DATA COLLECTION: I have conducted manual count at Jagdevpur mandal, Medak district (Teegul to Ramnagar Road) and are represented in tally sheets.

Table-1: indicates the traffic flow at Teegul road and Ramnagar Road (after multiplying with PCU factor).

Traffic Volume Data Location: JAGDEVPUR MANDAL Direction: From: TEEGUL To: RAMNAGAR (BOTH DIRECTIONS)								
	Time	Cycles	2 Wheers	lcv/Tractors	bus/ vans	cars/ Trucks	Others	Total vehicles
Morning	09:00-09:15	3	2	11	0	9	36	61
	09:15 -09:30	0	1	6	0	0	24	31
	09:30-09:45	1	3	6	9	0	12	30
	09:45-10.00	2	1	8	0	0	6	16
	10:00 -10:15	1	4	11	3	3	24	45
	10:15 -10:30	0	1	8	0	3	24	35
	10:30 -10:45	2	3	9	0	12	24	50
	10:45 -11:00	0	1	9	0	0	24	34
	11:00 -11:15	0	3	9	0	3	6	21
	11:15 -11:30	1	1	8	0	0	30	39
	11:30 -11:45	0	2	9	0	3	24	38
	11:45 -12:00	1	1	8	0	0	30	39
Evening	03:00 -03:15	1	2	8	0	3	6	19
	03:15 -03:30	1	2	3	0	6	12	24
	03:30 -03:45	0	3	6	6	0	30	45
	03:45 -04:00	0	3	6	0	3	6	18
	04:00 -04:15	1	3	2	12	3	30	50
	04:15 -04:30	0	4	6	0	12	24	46
	04:30 -04:45	2	1	8	6	3	24	43
	04:45 -05:00	0	4	11	0	0	12	26
	05:00 -05:15	3	2	6	6	12	30	59
	05:15 -05:30	1	2	6	0	0	6	15
	05:30 -05:45	2	1	8	3	0	6	20
	05:45 -06:00	0	3	8	0	3	24	37

Table-2: indicates the hourly traffic flow data at Teegul to Ramnagar Road.

	Time	Cycles	2 Wheers	lcv/Tractors	bus/ vans	cars/ Trucks	Others	Total vehicles (each hour)
Morning	**9:00 -10:00**	**5**	**6**	**30**	**9**	**9**	**78**	**137**
	9:15 -10:15	3	8	30	12	3	66	122
	9:30- 10:30	3	7	32	12	6	66	126
	9:45-10:45	5	7	35	3	18	78	145
	10:00 -11:00	**3**	**7**	**36**	**3**	**18**	**96**	**163**
	10:15-11:15	2	7	35	0	18	78	139
	10:30-11:30	3	7	35	0	15	84	143
	10:45 -11:45	1	6	35	0	6	84	131
	11:00-12:00	**1**	**6**	**33**	**0**	**6**	**90**	**136**
Evening	**3:00-4:00**	**2**	**5**	**32**	**0**	**6**	**90**	**134**
	3:15-4:15	2	7	27	0	12	72	119
	3:30-4:30	2	7	24	6	9	78	126
	3:45-4:45	1	9	23	6	12	54	105
	4:00-5:00	**3**	**10**	**26**	**18**	**18**	**90**	**164**
	4:15-5:15	5	10	30	12	27	90	**173**
	4:30-5:30	5	8	30	12	15	72	142
	4:45-5:45	5	9	30	9	12	54	119
	5:00-6:00	**5**	**8**	**27**	**9**	**15**	**66**	**130**
						Total PCU in day		**864**

4.3 Traffic Volume Survey and Analysis

The data collected from survey are recorded in Excel sheets, compiled, checked and corrected before further proceeding for analysis. Traffic data analysis has been carried out, to understand traffic characteristics and travel pattern in the study area and to provide basic input for Bridge design.

4.3.1 Traffic capacity calculation

$$Tn = To\ X(1+r)^n$$

Where

Tn ------- Traffic in the n^{th} year
To ------- Traffic in the zero year
r ------- Rate of traffic growth in decimals
n ------- Number of years

Data:
To = 864 pcu / day
r = 6% (as per IRC code)
n = 10 years (usually for rural roads)

Calculation:

$$Tn = 864 \text{ X } (1+0.06)^{10`}$$

Tn = 1547. 3 Pcu

As per IRC: 64-1990 the design service volume should be less than 2000 PCU/day
After calculation the obtained service volume is 1547.3 pcu /day
Thus is safe to design a Single lane Road bridge

5. STRUCTURAL DESIGN

1. Introduction: The Kaleshwaram Project, Main Canal is designed to carry a discharge of 110.880 m^3/sec.
The Kaleshwaram Project main canal on its way is crossing the existing road at Km 6.74, A Single Lane Bridge is proposed.
2. Vent Way: The depth of cutting at the proposed site is 15.433 M. Keeping in view of the Canal bed width and depth of cutting, 5 spans of 14.080 m C/C of Expansion joints are proposed. The afflux worked out in the canal is 2.15 cm, against 2.5 cm of loss of head proposed in approved hydraulic particulars.
3. Foundation Level: As abutments are buried and not in contact with canal flow, foundation levels of abutments are taken up to +521.700 m & foundation of piers are taken at Max. scour level 521.800.
4. Super Structures: The super structure is designed which contains two main girders and four cross beams in each span.
5. Sub Structure:

a) The height of piers-1&4 and pier-2&3 are 7.261m and 15.205m respectively. Piers are designed with four Rectangular columns with combined footing and foundation.
b) The abutments are of CC M15. The stability is checked and the stresses worked out at the top of concrete and the foundation strata on soil are found to be within the allowable limits.

6. Foundations:

a) Pier and Pier Foundation are proposed in R.C.C. M25 grade
b) Abutment foundations are of CC M 15
c) Stress table

d) Table-3 Indicating the stresses in foundation

S. No	Descriptions	STRESS ON CONCRETE		STRESS ON SOILS	
		MAX (t/m2)	MIN (t/m2)	MAX (t/m2)	MIN (t/m2)
1	ABUTMENT	26.551	0.064	23.378	4.602
2	PIER-1&4	-	-	26.894	1.172
3	PIER-2&3	-	-	26.978	0.553
4	RETURN WALL	7.559	5.693	0.677	2.753

6. ESTIMATION AND COST COMPARISION

Before taking up the construction of any structure is becomes a necessity to get to know the cost of the structure in order to establish sufficiency of funds. For quantification of the work items involved and evaluation of their cost from the process of estimation, a drawing has been prepared based on the design and the sizes of the various components arrived at.
Detailed quantities of all components of the structure are calculated as per the drawing evolved. Evaluation of the work items is made based on the market rates of the materials like coarse aggregate, cement, steel etc. and local labour.
Based on the above the estimate of the bridge is prepared and presented as follows:

Table-4 Indicating the SLRB Estimate Abstract

ABSTRACT ESTIMATE OF SINGLE LANE ROAD BRIDGE					
S.NO	**QUANTITY**	**DESCRIPTION**	**UNITS**	**RATE**	**AMOUNT**
1	2052.908	**Earth work excavation** with machinery cut in all soils upto Soft Disintegrated Rock and depositing outside the banks including **silt removal** as directed by the Engineer-in-charge.	**Cum**	39.000	80063.424
2	29.572	Vibrated Cement concrete with M-15 grade concrete confirming to compressive strength of 15.00 N/mm2 for **Levelling course**	**Cum**	2853.000	84367.775
3	109.741	Vibrated Cement concrete with **M-15 grade concrete** confirming to compressive strength of 15.00 N/mm2 concrete using well graded machine crushed Hard broken Granite metal maximum size of 40 mm down graded confirming to IS Code including cost and conveyance of all materials, labour charges all leads and lifts, seigniorage, and compacting concrete with vibrates, curing etc complete for **foundations and body walls of Abutments , Return walls** etc.	**Cum**	3693.000	405272.590
4	172.254	Vibrated Reinforced Cement concrete with **M-25 grade concrete** confirming to compressive strength of 25.00 N/mm2 concrete using well graded machine crushed Hard broken Granite metal maximum size of 40 mm down graded confirming to IS Code including cost and conveyance of all materials, labour charges all leads and lifts, seigniorage, and compacting concrete with vibrates, curing etc complete for **abutments cap, dirt wall & piers** etc.as directed by the Engineer in charge	**Cum**	5514.000	949805.799
5	203.121	Vibrated Reinforced Cement concrete with **M-30 grade concrete** confirming to compressive strength of 30.00 N/mm2 concrete using well graded machine crushed Hard broken Granite metal maximum size of 20 mm down graded confirming to IS Code including cost and conveyance of all materials, labour charges all leads and lifts, seigniorage, and compacting concrete with vibrates, curing etc complete for **Deck slab, beams,Approach slab,** etc.as directed by the Engineer in charge	**Cum**	5692.000	1156163.594
6	23.228	**Vibrated Reinforced Cement concrete M 35** grade concrete confirming to compressive strength of 35.00 N/mm2 concrete using well graded machine crushed Hard broken Granite metal maximum size of 20 mm down graded confirming to IS Code including cost and conveyance of all materials, labour charges, all leads & lifts seignorage, vibration and machine ,mixing **for wearing coat** etc complete.	**Cum**	5825.000	135300.188
7	20.000	**Elastromer Bearing**	**No's**	6200.000	124000.000
8	11.796	Supply and fixing of **HYSD bars** in position including cost and conveyance of material and straightening, cutting, bending including cost of binding wire and placing in position etc.	**Cum**	56000.000	660555.419
9	26.400	**Expansion Joints** with 20mm thick S&F of mastic pads	**Rmt**	73.000	1927.200
10	20.000	**Drainage spouts**	**No's**	1010.000	20200.000
11	24.000	**Guard Stones**	**No's**	91.900	2205.600
12	306.144	**Refilling** with useful excavated soils (other than sand) complying with standard specification for **filling foundation and sides of head walls, wing walls** etc.complete for finished item of work.	**Cum**	19.400	5939.187
		Total			**36,25,801**
		Total in Crores			**0.36**

Table-5 Indicating the DLRB Estimate Abstract

ABSTRACT ESTIMATE OF DOUBLE LANE ROAD BRIDGE					
STIMA	**QUANTITY**	**DESCRIPTION**	**UNITS**	**RATE**	**AMOUNT**
Before	1858.415	**Earth work excavation** with machinery cut in all soils upto Soft Disintegrated Rock and depositing outside the banks including **silt removal** as directed by the Engineer-in-charge.	**Cum**	39.000	72478.176
By qu	30.296	Vibrated Cement concrete with M-15 grade concrete confirming to compressive strength of 15.00 N/mm2 for **Levelling course**	**Cum**	2853.000	86433.917
A drav	281.269	Vibrated Cement concrete with **M-15 grade concrete** confirming to compressive strength of 15.00 N/mm2 concrete using well graded machine crushed Hard broken Granite metal maximum size of 40 mm down graded confirming to IS Code including cost and conveyance of all materials, labour charges all leads and lifts, seigniorage, and compacting concrete with vibrates, curing etc complete for **foundations and body walls of Abutments , Return walls** etc.	**Cum**	3693.000	1038726.786
Detail	61.678	Vibrated Reinforced Cement concrete with **M-25 grade concrete** confirming to compressive strength of 25.00 N/mm2 concrete using well graded machine crushed Hard broken Granite metal maximum size of 40 mm down graded confirming to IS Code including cost and conveyance of all materials, labour charges all leads and lifts, seigniorage, and compacting concrete with vibrates, curing etc complete for **abutments cap, dirt wall & piers** etc.as directed by the Engineer in charge	**Cum**	5514.000	340094.256
Evula	250.023	Vibrated Reinforced Cement concrete with **M-30 grade concrete** confirming to compressive strength of 30.00 N/mm2 concrete using well graded machine crushed Hard broken Granite metal maximum size of 20 mm down graded confirming to IS Code including cost and conveyance of all materials, labour charges all leads and lifts, seigniorage, and compacting concrete with vibrates, curing etc complete for **Deck slab, beams,Approach slab,** etc.as directed by the Engineer in charge	**Cum**	5692.000	1423130.916
6	40.388	**Vibrated Reinforced Cement concrete M 35** grade concrete confirming to compressive strength of 35.00 N/mm2 concrete using well graded machine crushed Hard broken Granite metal maximum size of 20 mm down graded confirming to IS Code including cost and conveyance of all materials, labour charges, all leads & lifts seignorage, vibration and machine ,mixing **for wearing coat** etc complete.	**Cum**	5825.000	235257.188
Based	20.000	**Elastromer Bearing**	**No's**	6200.000	124000.000
8	89.998	Supply and fixing of **HYSD bars** in position including cost and conveyance of material and straightening, cutting, bending including cost of binding wire and placing in position etc.	**Cum**	56000.000	5039899.287
9	26.400	**Expansion Joints** with 20mm thick S&F of mastic pads	**Rmt**	73.000	1927.200
10	16.000	**Drainage spouts**	**No's**	1010.000	16160.000
11	24.000	**Guard Stones**	**No's**	91.900	2205.600
12	159.575	**Refilling** with useful excavated soils (other than sand) complying with standard specification for **filling foundation and sides of head walls, wing walls** etc.complete for finished item of work.	**Cum**	19.400	3095.763
		Total			**8,383,409**
		Total in Crores			**0.84**

CONCLUSION

The bridge under consideration is conceived based on the traffic study made at the location at the structure.
A single lane road bridge is felt sufficient to allow the traffic with volume projected over next 10 years to come.
Accordingly the bridge structure is designed as per relevant IRC&IS codes.
A detailed estimate and cost abstract are also prepared.
The bridge proposed in the govt. organization dealing with the subject is a DLB for which an estimate has prepared.

The estimates of both proposals are presented.
On examination and comparison of the above two estimates the following is observed.

- The cost of the designed structure(SLRB) is Rs. 0.36 Crores
- The cost of the DLRB prepared by the government organization dealing with the structure is Rs. 0.83 Crores

It is clear from the above that SLRB designed based on the actual traffic prevailing proves to be economical when compared to the cost of the DLRB proposed by the department.

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