International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

A COMPARATIVE STUDY OF CAUSEWAYS AND CULVERTS

Prajakta S. Deshpande[1], Prof. P. K. Pasnur[2]

[1]P.G Student Civil Engineering Department, JSPM'S ICOER, Wagholi, Pune.
[2]Professor Civil Engineering Department, JSPM'S ICOER, Wagholi, Pune.

---***---

Abstract – *Floods are the most critical among all the natural calamities in the world which causes severe damage to the lives and properties. There are so many villages in our country where during rainy season flood disconnects the roads between villages. Therefore for transportation purpose crossing on waterway is essential. But considering the financial condition of our villages, it is not possible to build bridges over the river. In this situation, the easy and cheap way is to build the causeway across the river. In this study, a vented causeway is designed for such two villages as per the IRC guidelines. The necessary data is obtained from Public Works Department and vented causeway is designed as per the requirements of IRC: SP: 82-2008 and IRC: SP: 62-2004. After this construction it will be convenient transport for the people in both the villages.*

Key Words: Flood, Causeway, Transportation, Vented, Crossing, Discharge, Manning's formula etc.

1. INTRODUCTION

There are various types of water crossings for low volume and less significant roads such as submersible bridges, causeways, fords, gabions etc. the merit of such structures lies in their economy and the life of structure depends very much upon their hydraulic design.

A causeway is one such paved submersible structure with or without openings (Vents), which allows flood to pass through and over it. These are proposed on rural and less important link roads not likely to generate much traffic in near future. The causeway may be proposed on streams of flashy nature with high frequency of short duration floods or at sites where construction of submersible bridges is not economically viable.

Culverts are the structures constructed across the drainage below the highway and railways for easy access for humans and animals. The dimensions of culvert are designed based on waterway. Thickness is adopted based on the loads acting on culvert and span of culvert.

According to the IRC specifications there are some criteria for the minimum width of the carriageway for causeways. This criterion is shown in the table below.

Table -1: Minimum width of carriageway for causeway

Category of road	Plain & rolling terrain	Mountainous & steep terrain
Single lane	6.8	5.5
Two lane	7.5	7.5

2. OBJECTIVES

The main aim of this paper is to provide a suitable water crossing on a river for the feasible transportation purpose. A vented causeway is designed as per the requirements of the IRC: SP: 82-2008 and IRC: SP: 62-2004. All the aspects of the vented causeway are studied with its advantages and disadvantages.

3. METHODOLOGY

3.1 HYDRAULIC DESIGN

To design a vented causeway the most important thing is the hydraulic calculations. This type of structures are depends on the hydraulic design. Therefore a proper calculation needs to be done according to find out the hydraulic data such as discharge, afflux etc.

3.1.1 Hydraulic data

Catchment area – 35.775 sq. m
Manning's constant (n) – 0.035
Hydraulic mean depth ® - 1.617
Bed slope (s) - 1/245
Lowest bed level (LBL) – 97.220 m
Highest flood level (HFL) – 100 m
Ordinary flood level (OFL) – 98.180 m

a) Velocity calculations

$V = 1/n \times R^{2/3} \times s^{1/2}$

Where,
V= velocity in m/s
n= Manning's constant
R= hydraulic mean depth
S= bed slope

V= 1/0.035 x $1.617^{2/3}$ x $(1/245)^{1/2}$
V= 2.515 m/s

b) Discharge calculations

Q= A x V

Where,
Q= discharge in cummecs
A= area in sq. m
V= velocity in m/s

Q= 35.775 x 2.515
Q = 89.964 cummecs

3.1.2 Hydrodynamic force of water current

Water current causes hydrodynamic force on the submerged part of a body. These forces on a member can be calculated by the following formula given in clause 2.13 of IRC 6

P = 52 KV

Where,
P = intensity of pressure due to water current in kg/m^2
V = velocity in m/s
K = constant (K=1.5 for rectangular pier)

P= 52 x 1.5 x 2.515
P= 493.368 kg/m^2

3.1.3 Estimation of afflux by empirical formula

h= [(V^2/17.9)+0.015] x [$(A/a)^2$ – 1]

Where,
h= Afflux in m
V= velocity in m/s
A= natural waterway area in m^2
a= constructed area in m^2

h= -0.231 m

3.1.4 Design details

Design discharge = 89.964 cummecs
Bank width at defined cross section = 24 m
Channel width at RTL= 25 m
Highest flood level (HFL) = 100 m
Lowest bed level (LBL) = 97.220 m
Ordinary flood level (OFL) = 98.180 m
Road top level (RTL) = 99.26 m

3.2 DESIGN OF CAUSEWAY

Internal diameter of pipe (m) = 1.2

Outer diameter of pipe (m) = 1.44

Road top level (RTL) m = 99.26

Channel width at RTL (m) = 25

Area (A) m^2 = 25(99.26-97.220) x 2/3 = 33.9 m^2

Assuming parabolic profile

Vent area of causeway = 13.56 m^2 (40% of A)

Number of pipes adopted = 12 =

$$\frac{13.56}{\frac{\pi}{4} x\, 1.44}$$

Clear spacing = 0.6

Total length = 12x1.44 + 11x0.6 = 23.88

Available vent area = 13.56 m^2

Percentage area of flow below road top level = 13.56/ 33.9 = 40%

OK if more than the minimum requirement of 30%

3.3 CHECK FOR OBSTRUCTION WHEN FLOOD LEVEL IS AT OFL

Approach gradient on either side (I in n) n = 20

Width of stream at OFL (m) = 23.88 + 2x20 (99.26-98.18) = 67.08

Area available for flow (m^2) = (67.08+25)/2 x (99.26-98.18) = 49.72

Total area available for flow (m^2) =49.72+13.56 = 63.28

Total area of flow before construction of causeway = 67.08x (100-97.220) x 2/3 = 214.32

Area of obstruction = 61.04

Percentage obstruction = 61.04/214.32 = 28.48%

OK if less than 30%.

4. RESULTS

Following is the summary of design of causeway:

Total available area of flow= 49.72 m

Width of stream at OFL = 67.08 m

No of pipes= 12

Type of pipe = NP4

Road top level (RTL) = 99.26 m

Area = 33.9 sq. m

Total length = 23.88 m

Percentage obstruction = 28.48%

5. DISCUSSIONS

From the literature survey it is found that causeway is cheap and easy to build.

As it is feasible for less important roads it is less durable.

Causeways are sometimes temporary structures for few years and also due to their low height they can be submersible during heavy rains and floods.

6. CONCLUSIONS

1. Causeways are cheap and easy way of providing a water crossing for less important roads.

2. If there is no more traffic and the roads are not so important then causeways are the best solution.

3. But considering the future aspects culverts are more durable and suitable option.

REFERENCES

[1] Thorsten Wagenar, Murugesu Sivapalan, Peter Troch, Ross Woods, "Catchment classification and hydrologic similarity", Geographic compass ¼ 2007-901-931, 2007.
[2] Heemika Upadhyay, Prof. Pradip Pandey, "Review on most efficient innovations in the field of bridge engineering technology", IJEDR/volume 6, issue 1/ ISSN: 2321-9939.
[3]IRC 6, standard specification and code of practice for road, bridge section II Loads and stresses, The Indian Road Congress 2014.
[4] IS: 456-2000 "Indian standard code of practice for plain and reinforced cement concrete", Bureau of Indian Standards, New Delhi
[5] IRC: SP: 82-2008 "Guidelines for design of causeway and submersible bridges", The Indian Road congress 2008.
[6] IRC: SP: 62-2004 "Guidelines for the design and construction of cement concrete pavements for rural roads", The Indian Road Congress 2004.
[7]IRC-SP: 13-2004 "Guidelines for the design of small bridges and culverts", The Indian Road Congress 2004.

BIOGRAPHIES

P.G. Student Civil Engineering Department, ICOER, Wagholi, Pune 412-207.
BE Civil (2019)

Professor Civil Engineering Department, ICOER, Wagholi, Pune 412-207.