Similar Study of Design of Box Culverts Manually and StaddPro software

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***Abstract*- Culverts are important hydraulic structures used to convey water across a road corridor or in one of a range of other situations. Culverts must be designed to convey this flow in an acceptable way, considering the hydraulic conditions and the required performance (level of flood immunity) of the road. Environmental and/or other requirements may also need to be considered, incorporated, depending on the specific circumstances. In this paper describes how to build HPC, Slab and box culvert and provide justification with standard drawing.**

***Index terms*- Culvert (HPC, Slab and box culvert)**

INTRODUCTION

Structural and Configuration requirement of culverts:
Loads on buried culverts include:
Fill over the structure, which is a function of:

- height of fill
- type of fill material
- installation conditions (such as 'trench' or 'embankment')

a. design traffic loads
b. construction traffic loads
c. other or abnormal load conditions.

The load bearing capacity of a culvert is a function of:

- unit strength (for example, pipe class)
- type of bedding and backfill material
- pipe diameter (excluding box culverts)

Improved layout of culverts
The risk of damage to culvert bases may in some circumstances be reduced by limiting the size of banks of culverts. In wide floodplains, it is considered that a number of banks of culverts distributed across the watercourse will result in a better hydraulic and structural solution.

Other structural solutions
The uses of stiffened raft foundations (AS 2870) are technically proven solutions widely used in the building industry. As the culvert distress is commonly observed within the apron area of the slab, any stiffening needs only be confined to the apron slab. Swell pressures can be as much as 200 kPa; that is, much greater than to be optimized. However, expansive soil issues with bridge abutments and general bridge maintenance requirements would still need to be resolved. Bridges would not be a practical option for low height structures applied pressure at the base of the slab (typically up to 50 kPa). Each case has to be Consideration should be given considered on its own merit.

Other options – bridges
Using short span bridges founded on freestanding piles extending to the stable material below the active zone. Due to the limited nature of contact between the volumetrically active soil and the foundation elements, being the free standing piles, limited upward thrusts are transmitted to the deck. Therefore, these foundation systems are less influenced by the movement of the ground and allow such designs, but the actual height limit has not currently been determined, and it may vary for different sites.

Codal References
Design Discharge
Estimated Flood Discharge from Flood Marks on an Existing Structure Having collected the necessary information from inspection as mentioned in para. The discharge passed by an existing structure can be calculated by applying an appropriate formula.In Article some formulae for calculating discharges from flood marks on existing bridges arediscussed. Distinct water mark on bridge piers and other

structures can be easily found immediately following the flood. Sometimes these marks can be identified years afterwards but it is advisable to survey them as soon after the flood is possible. Turbulence, standing wave and slashing may have caused a spread in the flood marks but the belt of this spread is mostly narrow and a reasonably correct profile of the surface line can be traced on the sides of piers and faces of abutments. This is perhaps the most reliable way of estimating a flood discharge because in the formulae discussed in Article- 1 5 the co-efficient involved have been accurately found by experiments.

Fixing Design Discharge

The recommended rule: Flood discharges can be estimated in three different ways as explained in Para of SP13 code. The values obtained should be compared. The highest of these values should be adopted as the design discharge Q, provided it does not exceed the next highest discharge by more than 50 per cent. If it does, restrict it to that limit. Sound economy: The designer is not expected to aim at designing a structure of such copious dimensions that it should pass a flood of any possible magnitude that can occur during the lifetime of the structure. Sound economy requires that the structure should be able to pass easily floods of a specified frequency (once in 50 years) and that extraordinary and rare floods should pass without causing excessive damage to the structure or the road. The necessity for this elaborate procedure for fixing Q arises for sizeable structures. As regards small culverts, Q may be taken as the discharge determined from the run-off formula.

Linear waterway The General Rule for Alluvial Streams: The linear waterway of a bridge across a wholly alluvial stream should normally be kept equal to the width required for stability, viz,.

Unstable Meandering Streams: A large alluvial stream, meandering over a wide belt, may have several active channels separated by land or shallow sections of nearly stagnant water. The actual (aggregate) width of such streams may be much in excess of the regime width required for stability. In bridging such a stream stability, viz.,

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Records of culvert designs should be retained for at least the lives of the culverts. The amount and detail of documentation should be related to the importance of the structure. The following data would normally be retained for large culverts: •

Field notes and data •
Site plan, profiles and cross-sections •
Soil data •
Summary of calculations •
Design flood frequency •
Headwater depth •
Outlet velocity •
Culvert drawings •
Rationale for culvert choice •
Photographs of site and developments,
If there is a possibility of future claims resulting from the hydraulic performance of the culvert. •
Flood data observed during and after construction of the culvert

Design Loading

Culverts and bridges of 6m, 6.4m and 7.5m overall widths on rural roads are normally designed for two lanes of IRC Class A loading with impact.

Minimum span:

From the consideration of maintenance of culverts, it is preferable that the clear waterway of pipe culvert is 1000 mm (900 mm internal Φ). Culverts of small span or diameter get choked due to silt. It is not possible to enter the pipe and carry out inspection and repairs. Irrigation pipes do not come under the purview of pipe culverts.

Headwall:

The Headwalls are raised up to top of the crust level of the road. The length of headwall isequal to four times the diameter of pipe for retaining the slope of earthen bank within 1(Vertical) to 1.5(Horizontal). Longer head walls are provided for wider streams as per site requirements. Suitably designed RCC face wall (150mm thick) can also be used for single row pipe culverts.

Rough calculation of length of Body walls.
Length of the body wall L =2H+(nD+(n-1)D/2)+0.60
Where H=Ht. of the Body wall from the Bed Level, N=No.of vents, D= Dia. of Pipes in Mtrs.
It shall be ensured that the invert of the pipe is placed 150mm below the average bed level and the Headwall shall be parallel to the road alignment.

Load case for Design
Mainly three load cases govern the design. These are given below
Box empty, live load surcharge on top slab of box and superimposed surcharge load on earth fill.
Box inside full with water, live load surcharge on top slab and superimposed surcharge load on earth fill.
Box inside full with water, live load surcharge on top slab and no superimposed surcharge on earth fill.

Design Methodology
The design discharge was fixed after arriving discharge based on the following methods:-
As per the hydraulic particulars furnished by the Irrigation department
By Area-Velocity method using Manning's equation for arriving at the flow velocity and area by considering actual cross-section of the channel.
Hydraulic particulars like HFL, OFL are obtained from Irrigation department.
Bottom of deck level was fixed based on HFL and road formation levels on both sides. The vertical clearance and afflux are verified.

CONCLUSION

If in any location the span exceeds from the above mentioned criteria then designer has to design structure manually by considering code references Reason behind being economic structure is that when we design structure we consider the load combinations which are applied to the structure which in any case make the structure fully loaded and designer consider that full load condition for the design and slope adopted for the abutment or pier Since looking forward for the second parameter that is the looking to the economical condition for the design of structure thereby I can strongly recommends for the standard specification drawing which are much more economical then the manually designed structure.

Hence the manually designed structure here in this case are more economical then standard specification drawings but the strength criteria satisfy more in standard specification drawings

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