



# Design of Haunches in the Rectangular RCC Box Culvert



**Ishaan Pandey\***

*Department of Civil Engineering, Invertis University, India*

**\*Corresponding author:** Ishaan Pandey, Assistant Professor, Department of Civil Engineering, Uttar Pradesh, India,

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## Abstract

As the need of science and dependency of the mankind on science and technology is increasing day by day, and focus is more laid on reliable and durable things to support sustainable development, there is a need to develop civil engineering also. In this paper we will try to understand about the haunches in culverts and their importance of designing. This small aspect can benefit the engineers in increasing reliability and durability of the structure. Various researches have already taken place in this area but a proper design method is yet to be introduced for haunches. This paper will provide an idea for a well defined approach of developing method of design for the haunches.

## Introduction

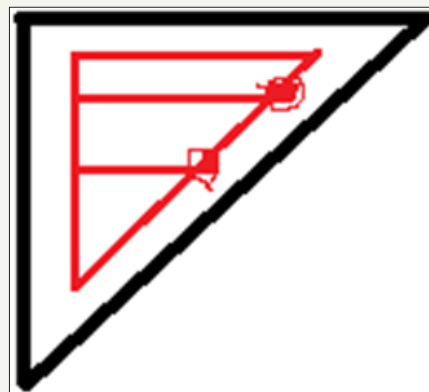
The method of analysis is an important aspect for the design of durable RCC box culvert [1] along with the thickness of haunches and its variation. With these two aspects, the reinforcements in the haunches and its schedule are also important considerations to make the structure durable and attain better strength for the load transfer. In this paper, an attempt has been made to develop a bar bending schedule for the haunches in RCC box culvert to withstand the applied loads and forces. The design of haunches should be made a different topic and should be included in overall design of rectangular box culvert. The analysis should be made through FEM (Finite Element Method) to achieve more economical design [2-5].

## Discussion

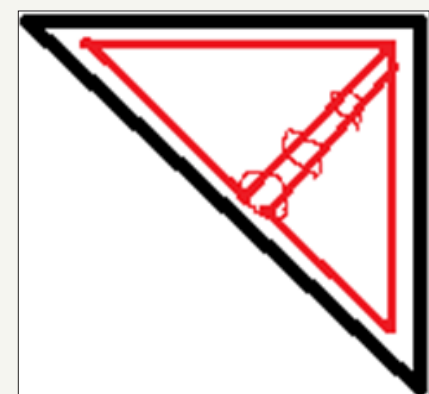
A culvert is subjected to various types of loads. The stresses generated are accumulated at the corners of box culvert. Thus, there is a need of haunches that provide a slight bend at the corners so that the stresses are not accumulated and make the structure vulnerable to fail or deform. Hence, haunches play an important role in withstanding the applied loads and forces. There is also a change of nature of stresses over the small length of haunches. So, the corners are most sensitive to applied load and forces [6,7].

The bars in the haunches can be bent along the perimeter with sufficient clear cover along with two bent up bars at 90° inside the haunches. This may ensure the horizontal impulse is safely resisted by the structure. The bent up bars should extend to the bars of perimeter and tied together to give a stiff bound schedule. Figure 1 shows the diagram of bar bending schedule of such arrangements. Such arrangement can be used for the spans up to 4m. This

arrangement would protect the weak concrete to fail in changing nature of stresses, from negative to positive and vice versa.



**Figure 1:** BBS of haunch with tied bent up bars.



**Figure 2:** BBS of haunch with corner pointing bars.

The other arrangement that may be used in haunches is to bent one bar along half perimeter at 90o that will end bending at the mid pointing towards the corner and other bar bending from below to half hypotenuse and ends bending pointing towards corner. The mid bar would protect haunches against earthquake force, impact loads of moving vehicles. Figure 2 shows the arrangement. Both corner pointing bars should be tied with each other.

The above two conditions are best suited because it will not require any extra bar or increased expense to develop strength in the haunches. The schedule of bar is also not very complex. Haunches are loaded from all the sides and can have both natures of stress. The changing stress natures need to be resisted to prevent concrete corners from failing. Hence reinforcement bars are provided to cover all sides of haunch. High tensile and compressive strength of steel bars ensures the smooth transfer of load to side walls and ultimately to the ground.

- a. The minimum clear cover should be such that the reinforcement is safe against rusting.
- b. The tying of bars should be at least at three equal distances.

## Conclusion

An approach of haunch design can be developed to ensure overall economic and safety of RCC box culvert. The finite element analysis and proper bar bending schedule for the haunches are

necessary to upgrade the methodology of design. Proper analysis will surely confirm the prominent way and formula for design of haunches and RCC box culvert.

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