Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 7, Issue 2; April-June 2020, pp. 185-187

http://www.krishisanskriti.org/Publication.html

Study of Foundations for Minor Bridge over Small River

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Abstract—*In bridge constructions, the foundation is a very important component to make the entire superstructure stable. The bottom portion of a structure is usually mentioned as a foundation. In general, for bridges located on Small Rivers, the deep foundation is directly used in the form of a pile. The main aim of the foundation is to transmit a load of superstructure and substructure to the bed. The well-designed foundation should transfer the stresses uniformly throughout the base. Foundation may be a supportive component of a framework that is situated below the framework and is only protected by soil or rock. Supporting the system is primarily inclined to then spread the burden of the system, so it slows down equally rather than unevenly. The structure designer should be fitted with a helpful computing instrument, with the aid of which he can easily and accurately evaluate the suitability of varied configurations and sub-structure specifications before finalizing the sub-structure's top ideal specification. In the current situation, for any developing country, it is very important to connect the most corner place of the country and due to this; all have to know the importance of minor bridges especially over the small rivers because many of the roads include many areas to cross small waterways. It is important to understand the suitability of the foundation for small and medium type rivers. The main aim of this study is to understand the suitability of foundation mainly in Medium River and concentrates on Experimental and Numerical designing of a good foundation including their comprehensive detailing. Wellfoundation may be a sort of deep foundation which is usually provided below the water level for bridges. From the study, it is concluded that the well foundation bridge on medium type river is more efficient and economical than other types of foundation such as pile foundation, raft foundation.*

Introduction

The bridge construction that includes too many obvious structural components as well as below the bottom, they can look simple but the study and hence the structural design of all these components, also the only type of bridge is always a fairly laborious and tedious task, particularly concerning the varied elements of the bridge. Typically the section of the bridge construction is listed below the bearing scale and above the starting level because of the substructure. Bridge substructure preparation is a critical aspect of a bridge's general construction and greatly influences the bridge's appearance, protection, and hence the economy. The main objective of the substructure is to spread the upcoming loads form the superstructure to the soil subgrade safely in such a manner the stresses should be in the permissible limits. Hence we can say that the design of the substructure is very important and playing the main role in whole design and analysis. The settlements and deformations also should be in such a manner that is to be in permissible limits. Theselection depends on many factors, including the character of the subsoiland the location of the Bridge either it over the Small River or Major River.

Classifications of foundations which are considered for typical Bridge design over Rive are as follows:

1. Well foundations (WF): for both road & railway bridges, it is the most common form of foundation in India. These foundations are often sunk to great heights and can hold heavy vertical and lateral pressures.

2. Pile foundations (PF): consist of comparatively prehensile parts, known as piles, which can be used to move loads to farther along or rock strata with the high bearing ability through poor soil or water. They can also be used for elevated roadways in natural landscape settings. The complete design of the pile foundation is based on the design of pile and pile caps including the detailing of reinforcement due to this the design and analysis of these types of foundation are very time taking and tedious. The total required concrete is in huge amount and the reinforcement required is also very much more.

3. Raft foundation: As just in the case of foundation the contact area of the inspiration with soil is far quite the other sort of foundation, therefore the load is distributed over a bigger area and thus the strain on the soil is lesser and therefore the possibility of shear failure of soil is additionally reduced.

This paper is based on the suitability of the foundation of a bridge over Medium River and concentrates on Experimental and Numerical designing of well foundation including their estimate. It is found that the well foundation bridge on medium type river is more efficient and economical than a pile foundation. Many of the locations existing over the medium river, Well foundation are provided in that case.

1. Design Data

In this study, the design discharge (Q) is considered as 410 meter cubic per second. The highest flood level (H.F.L) and lowest water level (L.W.L) is assumed as 100 and 94 meters respectively. The length of the bridge is taken as 77.75 meters along with the wearing coat of 0.075 meters and roadway of 7.5 meters. Concrete used for plugs, kerbs and crash barrier is of M-20, M-40, and M-30 respectively with Fe-500 grade of steel. Some other important parameters considere for the study are as follows:-

1. Span arrangement = 5 × 15 m c/c of bearing with designed Loading = 2 Lane class A or single-lane 70R
2. Formation Level = 106.25m
3. Outer dia of well = 6.0 m
4. Inner dia of well = 4.9 m
5. Silt factor = 1
6. Submerged unit weight of soil (γ_{sub}) = 10 kN/m^3
7. Soil bearing capacity at bottom of WF = 490 kN/m^2
8. In the Soil properties below well cap considered the Zero Cohesive force including the Internal angle of fraction (ϕ) = 30°
9. Clear water way = 5 × 15 −2.0 × 2.0 − 2.0 × 1.2 = 68.6 m
10. Lacy's waterway depth =$4.8\sqrt{Q}$=97.19 m
11. Restriction=100−$\frac{68.6}{96} \times 100$ = 28.54 %
12. Discharge/meter =$\frac{410}{68.6}$=5.97 m^3/sec/m
13. Mean Scour depth (dsm) =1.34 $\left(\frac{d_{sm}^{\ 2}}{k_{sf}}\right)^{\frac{1}{3}}$ = 4.41 m
14. Scour depth below Highest Flood Level
    - **(a)** For pier = 2 × 4.41 =8.82 m
    - **(b)** For abutment = 1.27 × 4.41 = 5.60 m
15. Depth of the foundation = 8.82 + $\frac{4.41}{5}$ =9.97 m but we provide 15.0 m including cutting edge
16. Depth of well required below Lowest water level or Top of well cap = 9.97-6= 3.70 m$<$10.00 m (proposed)
17. M.S.L. of pier well = 100.00 − 2 × 4. 1 = 91.18 m say 92 m, Mean scour level of abutment well , 100.00− 1.27 × 4.41 = 94.39 m which lie within abutment well cap mean scour level kept same as pier well.

2. Study and Discussion

The design of well foundation for medium type river has been finished the discharge of 410 m3/sec. From the above study, we can conclude that the Bridges that are to be constructed on well foundation over medium type river are efficient and straight forward to construct. The Reth river bridge system sector analysis was examined and stated in paper-1 et-al Varma Rakesh and Srivastava Rajendra Kumar Published in International Conference held in Ram Swaroop Memorial University Analysis of current Bridge Structures in Small River in the Uttar Pradesh alluvial area in 2019. During this article, the authors acknowledged the kind of bridge structure in Barabanki U.P. district over the river Reth having around 75 km of length(Referred Table No.1) Considering this methodology research, it has been found that 10 bridge numbers are given below. Total river flow of 106 m^3 / s. Well foundation is typically provided when the soil is sandy. This kind of bridge base is ideal where there is good soil about 3 to 4 m below the river bed level. It is ideally suited for soft ground or sandy fields and the river bed appears to be more scouring due to the rapid approach pace of the river water.

Table 1 Bridge location and Type

Sr. No.	Chainage (Km.)	Category Foundation	Connected Location
1	2.86	WF	Barkernagar, Parimathpur
2	6.2	WF	Gyannagar, Diyantnagar
3	13.63	WF	Sarifabad, Attyarrpur
4	22.20	WF	Bergaadha, Saheria
5	35.44	WF	Munaira
6	42.50	WF	Waadinagar, Saheliya(Darapur),
7	48.00	WF	Lucknow-Barabanki road (Old)
8	56.860	WF	Doonpurwa Banki road, Chillhata, Punaurapur
9	63.049	WF	Kaithesaraiyya, Dewa road
10	71.960	WF	Garhi, Chindvahi

3. Conclusion

1. From the above study, it can be analyzed that the majority of the minor Bridges over the Small River are constructed on the WF, which is economical than pile foundations. The well foundation is mainly bearing based foundation which is suitable for the alluvial region which is soft soil in nature.
2. Pile foundation is not economical over small rivers.
3. Well foundations are used but not economical as compared to the raft foundation.
4. Raft foundation can be used for water channels by use of the barrage system.

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