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TITLE:-COST EFFECTIVENESS AND FEASIBILITY STUDY ON FOUNDATIONS ON SLUSHY SOILS FOR BRIDGES

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I. INTRODUCTION

In the conventional practice, the foundations of major bridges are anchored firmly into sound rock or to a depth where the stresses are nullified. Over the years, several engineers have developed raft foundations as available alternative for deep foundations such as wells and piles where the economical costs for the later are high and also the access of such equipment in rural areas is remote. Sand cushion is one of the ground improvement techniques which are being used to improve the low bearing capacity and reduce high settlement of problematic soils. Satyanarayana (1966) who can be considered the father of this technique improved the soil characteristics by replacing high PI soil with sand. In the sand-cushion method, the expansive clay stratum which is difficult for leveling ground under bridge abutments is completely removed if the thickness is small or partially if the clay layer is deep, and replaced by a sand cushion compacted to the desired density and thickness. Sand cushions have some limitations like accumulation of water below the raft due to accumulation of water, and secondly, the determination of active zone up to which the sand cushion is to be taken is a difficult task. Different feasibility studies have been conducted by several authors using different materials. Hassona et al [1] considered the feasibility of using waste tire as an alternative reinforcement material in soil clay soil using reinforced sand cushion and comparison of its effect with popular reinforcing materials such as geotextile and geogrid. Seeing the benefits of raft foundation, design and construction engineers of Maharashtra [2] have been constantly innovating in this technology to achieve economy and furtherance of constructional ease. Dewatering is one of the major problems faced in the construction of raft foundations especially in case of sandy soils and structures near irrigated areas. As a scope for further study, we can try the cost-effectiveness and feasibility study of the current ground improvement technique using composite piled raft foundation [3]. In customary foundation design, it is usual to consider first the use of shallow foundation such as raft with any ground improvement performed. If it is insufficient, then deep foundation such as a fully piled foundation is considered. In recent times, another alternate intermediate approach between shallow and deep foundation, which is called piled raft foundation or settlement reducing piles foundation, has be identified by civil engineers. This can be checked with the current study to see the efficiency of the working stress method of normal raft approach.

Design of raft foundation for bridge structure in various types and cost analysis

The project work is mainly based on a model design for a bridge structure with all abnormal conditions like poor SBC of soil. The bridge is located in rural belt of a state highway where the limit state design cannot be adopted. So working stress design is adopted for the design of all the components. The soil underneath the foundation is assumed to be of high PI value with more permeability and easily prone for scour. To arrest uneven settlement of raft it is proposed to put sand cussion under the raft to a depth of 50cms. Special focus is given for practical work considerations (fesibility of construction) along with cost effectiveness.

A. Scouring action

The codal provision as per IRC 5 1970 specifies the following formula d=0.473(Q/f) 1/3
Where d= Normal depth of socour in meters in below the flood level corresponding to the value Q
Q= the design discharge in m3 /sec
f= silt factor for representative sample of the bed material = $1.76\sqrt{m}$
m=Mean diameter of particle in mm
in IRC 78/1983 has propagated another equation which seems to be realistic

dsm = 1.34 (Db 2 /ksf) 1/3

where dsm is mean scour depth With the above concept the present case amounts to scour depth at piers is nearly 13mts from MFL and the excavation part it self will be very costly and practically very difficult to execute. The other option in such case is to go for well foundation and which is still very costly and the bridge is located in rural belt with less than moderate traffic.

B. Feasibility conditions

Even though the small streams in the above case are semi perinial the excavation of the entire area and preparation of ground for the laying of concrete is difficult. If the reinforcement is to be provided in case of RCC raft it would be very difficult to maintain the lengths and alignment of grills in the bottom part of structure where exists more slurry type of soil. In academic interest a combination of cost effectiveness versus the feasibility of laying the raft is discussed in the following paragraphs.

C. Concrete foundation bed for a larger area in contact with the slushy soils

In practical conditions to achieve a level ground in slushy

soil is very difficult so as to achieve this condition the slushy surface is to be filled by a soil having zero PI value so the the next layer of concrete can be out directly over that. The traditional practice of this kind of work is by putting a layer of sand cushion over the slushy surface

D. Advantage of sand cushion
It arrests differential settlement of the concrete and because of having a very low PI value it works as a drainage layer

Sill level
Top of raft
Bottom of raft
Sand cushion
The present topic for discussion is to find an economical and feasible condition for execution of raft for which there are various options

Option 1) laying Plain cement concrete raft
This option involves directly laying raft with plain cement concrete over a nominal sand cushion of 30cms. The design of above member worked out to a thickness of raft as 1.10mts. By adopting this option the Running meter cost (considering a strip of 1mt x1mt) is as follows

a	for concrete 1.10cum @ Rs 5000/1cum	Rs5500
b	For sand cushion 0.30cum @Rs 1000/1cum	Rs300
c	Miscellaneous charges for bailing out water shoring shuttering etc	Rs200
	Total	Rs 6000/1cum

Feasibility condition for the above work is with a weight age of 80% (as discussed in appendix for weight age points)
In Abstract the cost involved is Rs 6000/1cum with feasibility weight age of 70points

Option 2) laying Reinforced cement concrete raft designed as per working stress method
By adopting this option the Running meter cost (considering a strip of 1mt x1mt) is as follows

a	for concrete 0.40cum @ Rs 6000/1cum	Rs2400
b	For sand cushion 0.30cum @Rs 1000/1cum	Rs300
c	Cost of HYSD bars for 0.4cum of concrete reinforcement including barbending placement etc for 150kg/1cum=60kgs@Rs 50/1kg	Rs3000
d	Extra depth in substructure to an extent of 70cms to be constructed in PCC M25 for 5 piers and 2 abutments average 35cms @5000/1cum	Rs1750
	Miscellaneous charges for bailing out water shoring shuttering etc	Rs200
	Total	Rs7650

E. Feasibility condition
Since this is an RCC construction the depth of massive raft is reduced due to the flexural capacity but the other charges like cost of reinforcement and the construction of remaining height with the substructure works out to extra quantities of concrete so the cost is increased. Regarding the feasibility the design is done in working stress method it may not require highly sophisticated laboratory for mix designs and Quality assurance , but the minimum infra structure is required so the feasibility weight age points as per the chart in appendix is 60%

Option 3) laying Reinforced cement concrete raft designed as per limit state method
Design by limit state method done for the above raft by considering all the values of stresses as ultimate values and factored loads thus reducing the factor of safety as it was in working stress method, it requires more quality assurance and skill in execution
By adopting this option the Running meter cost (considering a strip of 1mt x1mt) is as follows

a	for concrete 0.40cum @ Rs 6000/1cum	Rs2400
b	For sand cushion 0.30cum @Rs 1000/1cum	Rs300
c	Cost of HYSD bars for 0.4cum of concrete reinforcement including barbending placement etc for 130kg/1cum=52kgs@Rs 50/1kg	Rs2600
d	Extra depth in substructure to an extent of 70cms to be constructed in PCC M25 for 5 piers and 2 abutments average 35cms @5000/1cum	Rs1750
	Miscellaneous charges for bailing out water shoring shuttering etc	Rs200
	Total	Rs7250

F. Feasibility condition
As the design is done in limit state method the quantity of steel is reduced to an extent of 20kgs per cum of concrete. Other conditions are same as in the above option II Regarding the feasibility the design is done in limit state method it requires highly sophisticated laboratory for mix designs and Quality assurance. The feasibility weight age points as per the chart in appendix is 50%

II. FEASIBILITY CHART

Item of work	Option1	Option2	Option3
Site conditions a)Soil good -5 b)Slushy soil(working environment difficult) -10	-10	-10	-10
Labour a)Can be handled with unskilled labour	-5	-5	-10

-5 b)Skilledlabour required-10			
Laboratory facility a) Not required -5 b)Required-10	-5	-10	-10
Sophisticated machinery for work a)Not required -5 b)Required -10	-5	-10	-10
HighQuality assurance a)Not required -5 b)Required -10	-5	-5	-10
Total	70	60	50

Feasibility chart is prepared by noting down the deficiencies in the site of work in relation to the requirement of various aspects like site conditions, labour, laboratory facility, sophisticated machinery, high quality control assurance

III. CONCLUSION

For structures in rural belt where proper laboratory facility and infrastructure is not available it would be better to adopt working stress method for design and execution.

REFERENCES

[1] Faek A. Hassonaa, Mohamed.A. Hassanb, Nahed A. Marei, "Improvement of Soft Clay Characteristics Using Sand Cushion Reinforced with Shredded Waste Tire", Faculty of Engineering, Al-Minia University, Egypt.
[2] Ms. Ashwini Ugalmugle & Dr. A. G. Namjoshi, "Construction of Raft Foundation in Deep Sandy Beds for Major Bridges Across Perennial Rivers".
[3] V.J.Sharma, S.A.Vasanvala, C.H.Solanki, "Effect of Cushion on Composite Piled Raft Foundation in Layered Soil Under Seismic Forces", International Journal of Scientific Engineering and Technology, Vol. 1, Issue No. 6, pp. 314-322.
[4] Bridge code IRC 78-2000
[5] IS 456-2000
[6] Bridge engineering by D.R PATHAK
[7] Bridge code IRC 5-1998

