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Attention : Ms. R. Mudali

GEOTECHNICAL ASSESSMENT OF FOUNDING CONDITIONS FOR PROPOSED PEDESTRIAN BRIDGE, MBOKODWENI RIVER, UMLAZI

It is proposed to construct a pedestrian bridge across the Mbokodweni River, at the southern extent of 121747 Street (Philani Shopping Centre). To this end a geotechnical appraisal of the site was carried out, the results of which follow.

1. Field Observations

Although the present river channel is barely 10m wide, the river basin is closer to 150m wide. It is known from previous field investigations on the adjacent Philani Shopping Centre site that this river has considerable energy during flood situations and boulders buried in the alluvium can be metres in size although they are typically less than about 600mm in size.

The site is underlain at depth by Dwyka Group tillite bedrock however the river has deposited alluvial sands, cobbles and boulders over the bedrock. There is a small outcrop of rock where the present informal crossing meets the southern bank, but south of that, deep alluvium is expected again on the southern scour bank of the river. Bedrock was not seen on the northern bank.

A traverse of Dynamic Cone Penetrometer tests was carried out across the river but results were, unsurprisingly, inconclusive. These refused on boulders within 1.5m each time (typically much shallower).

2. Past Investigations

It is known from four boreholes drilled for a pipe crossing about 1.5km downstream, in a similar geological and topographical setting, that between 7.5 and 8m of sand and clay alluvium containing **abundant** hard rock cobbles and boulders overlies very hard rock tillite bedrock in the river bed. Given the similarity in setting there is no reason to believe that similar subsoil conditions do not prevail under the site of the proposed Mbokodweni pedestrian bridge.

The borehole logs were recorded on the GIS as follows :

Borehole log ID 1994

0.0-3m: BOULDERS & COBBLES to 1.2 m in sand matrix over brown coarse & medium SAND with pebbles.
3-7.95m: Pink, grey, fresh, very to extremely hard rounded BOULDERS, PEBBLES & COBBLES of quartzite, tillte, sandstone. Matrix not recovered.
7.95-10.54m: Blue-grey fresh very hard close to medium jointed Dwyka TILLITE. Joints iron stained, rough, 20, 45 & 70 deg.

Borehole log ID 1995

0.0-7.98m: Pink, grey fresh very to extremely hard rounded BOULDERS, PEBBLES & COBBLES of quartzite, tillte, sandstone. Matrix not recovered.
7.98-9.36m: Blue-grey fresh very hard close to widely jointed Dwyka TILLITE. Joints iron stained, rough, 20 & 80 deg, wider spacing with depth.

Borehole log ID 1996

0.0-5.25m: Wet brown medium & coarse SAND.
5.25-6.07m: Grey to pink tillite, quartzite, sandstone PEBBLES in a sandy clay matrix.
6.07-7.5m: Pink very hard fresh BOULDERS, COBBLES & PEBBLES of sandstone, quartzite.
7.5-12m: Dark grey fresh very hard Dwyka TILLITE. Widely jointed to close in zones. Joint orientation 20 deg to 45 deg with iron stain on joint faces.

Borehole log ID 1997

0.0-7.8m: Pink, grey fresh very to extremely hard rounded BOULDERS, PEBBLES & COBBLES of quartzite, tillte, sandstone.
7.8-10.66m: Blue-grey fresh very hard close to widely jointed Dwyka TILLITE. Joints iron stained, rough, 20 & 80 deg, wider spacing with depth.

3. Founding Options

Ideally, all bridges should be anchored into the bedrock to reduce the potential for undermining by erosion and rotating or toppling during high flow volumes. This can become extremely costly on a river of this magnitude particularly with the prevailing boulder strewn alluvial profile. A balance will have to be found between the cost of optimum founding into bedrock and the scale of the project.

Founding options are limited by the site conditions and budget.

- Footings onto rock for mid-stream piers are not possible with rock at up to 8m depth. The logistics and safety of open trenches to 8m below water level are not worth considering, not to mention the difficulty of excavating and raising boulders from that depth in a confined space. Shallow footings into the sandy upper alluvium will almost certainly be damaged if not washed away in the next, even minor, flood so are not considered further.

- Auger piles socketed into rock are not an option as the average auger rig (even using the larger diameters) will not progress through the thick, boulder supported layer. Rapid, early refusal will certainly be met.

- Driven precast piles with a rock shoe may be an option but it is suspected that even that may hang up early in a boulder supported layer. Driven steel H-piles are said to have a better ability to handle boulders than precast concrete. A site specific borehole drilling exercise at pier positions may give a more definite idea of the size and distribution of boulders at this location. Another possible shortfall is that the rock shoe probably won't penetrate the fresh, hard to very hard rock tillite bedrock at depth to provide any degree of anchoring so while not settling since it is resting on rock, it is just resting rather than being anchored into the rock. While the likelihood of the full depth of boulders being removed by flood waters is extremely remote the removal of lateral support if the upper sands are removed would have to be accommodated in the design and risk assessment. On the plus side, the driving rigs are often track mounted so will be more readily manoeuvrable in the river bed setting.

- A possible solution is the use of a percussion drilling rig to drill pile holes. Typically used for water borehole drilling, these machines grind the substrate to chips and dust so can progress through most materials; casing can also be pushed down while drilling to hold the hole open. Drilling will continue into the bedrock and a socket will almost certainly be achieved. This method was used to install piles through the old quarry spoil rock dumps at the Derby Downs office complex in Westville. The method is not without its limitations and challenges too. It is expensive as it is not the normal use for these machines; the larger diameters (compared to typical water boreholes) required for piles may require the purchasing of larger diameter drill bits. Casing can be caught by shifting boulders at depth and this rapidly balloons the cost due to delays and damage to equipment (especially if the drill bit is also caught). If grout injection is used, a proper seal between casing and bedrock is essential otherwise the cement just washes out with the flowing water. The rigs are housed on large trucks with attendant large trailer compressors and special drive-on access onto the river bed will probably be required.

- While a suspension bridge of some variety may avoid piers in the river channel, the excessive span of the river bed will necessitate a prohibitively costly design.

4. Conclusion

The contradiction between the scale of the river being crossed and the limited budget of a semi-rural pedestrian bridge is a challenge; the choice of founding solution will be a trade-off between cost and risk. Percussion drilling may give a technically better option in penetrating the boulders and anchoring into bedrock but is not without its own logistical challenges and probably will not be justified by the cost. If some risk of damage (degrees of erosion undermining or rotation) in a future flood is acceptable, driven preformed piles with a rock shoe are possibly a more cost effective solution. A track mounted rig will be mobile in sandy soils for installation; the strength and form of the piles is controlled above ground; the vibration and noise of driving is a distance from the nearest homes. Some design flexibility will have to be allowed for to move positions slightly if piles do hang up excessively short and cannot be retracted. Steel H-piles may be a better option than precast concrete given their superior boulder penetration ability.

If there are any further queries, please contact the writer.

Yours faithfully,

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