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MODIFICATION OF EXISTING CULVERTS ON RIVER OMI USING HEC-RAS

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ABSTRACT: *HEC-RAS (Hydrologic Engineering Center's River Analysis software) is a one-dimensional computer program that models the hydraulics of water flow through natural rivers and other channels [1]. It was used to modify the existing culverts on River Omi which in the past years and of recent has inundated its surroundings. The hydrological data was also measured and used as an input to the model. The model was used over MIKE11, flovial and other hydraulic mathematical model because of its high visual capability and complete output with detailed [2]. The results showed and confirmed that the existing culverts at the considered cross-sections could no longer accommodate the river's discharge. A box-culvert spanning 7.2m with a rise of 1.8m will be adequate and economical to replace the existing ones. The existing wing wall was sufficient for the modified cross-section.*

KEYWORDS: HEC-RAS, Modeling, River Omi, Flood, Culverts

INTRODUCTION

River Omi is located within Iddo Local Government area of Ibadan, Oyo State, Nigeria. It lies between longitude 3° 55' and 4° 00' East and Latitude 7° 00' and 7° 05' North of the equator. It flows through Omi-Adio which is also located at Iddo Local Government Area (LGA). It is one of the tributaries of River Ona in Ibadan, Oyo State, Nigeria. It takes its source from between Alasa and Mele in Akinyele Local Government Area (LGA) of Oyo State, and flows south westward through Elegunde, Apoyin, Omi-Adio, etc. and joins Ona river at Gambari forest reserve [3][4].The sampling points across the river are shown in Fig.1.

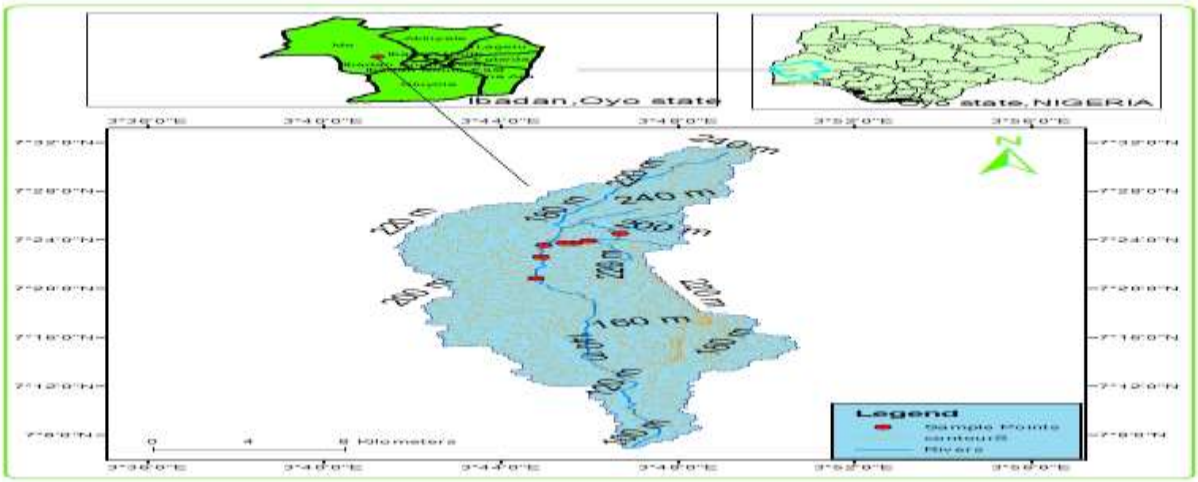

Figure 1: Map showing Designated Cross-Sections on River Omi (Olaniyan, 2012)

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The river has recorded varying degrees of flooding. For instance, there were flooding in the watersheds of streams (one of the two major streams in Ibadan) in 1955, 1960, 1961, 1963, 1969, 1978 and 1980. The flooding of 1969 was unique because it resulted from a mere 25.4 mm rainfall. The recent flooding on the river occurred in August 26th, 2011 [5]. This calls for immediate attention as the incessant inundation keeps claiming lives and properties. Flooding is inevitable, resulting from the natural rainfall-runoff process but can be alleviated. The major cause of flooding on River Omi is as a result of the non-functional culverts on it which have either collapsed or completely wear off in some areas. The study focus on re-designing of ineffective culverts on River Omi

MATERIALS AND METHODS

Rigid meter rule, ranging pole, lengthy water proof, data collection sheet, were used in this study. The meter rule and ranging pole were used to measure the dimension of the culverts**.** Figure 1 shows the map of the river and the measuring stations considered. The river reach was 14.1 km and seven sampling stations were considered. The velocity of the flow measured using a current meter (model 32956-00) and the turbidity of the water samples were measured using HI 93703 microprocessor turbidity meter. The cross-sections were designated Z_1-Z_7 with the exclusion of Z_4 due to its incessant dryness and Z_5 which already has a functional bridge which effectively accommodate the excess discharge of the river. The upstream stations are Z_1-Z_3 and the downstream were Z_6-Z_7.

The geometrical features used are the width, the length, the depth, and the wing wall length. The widths of the river at strategic points were as well considered alongside the bank conditions. Table 1 gives a summary of the culvert specifications on River Omi. Figure 2 show the reach considered on River Omi on HEC-RAS interface

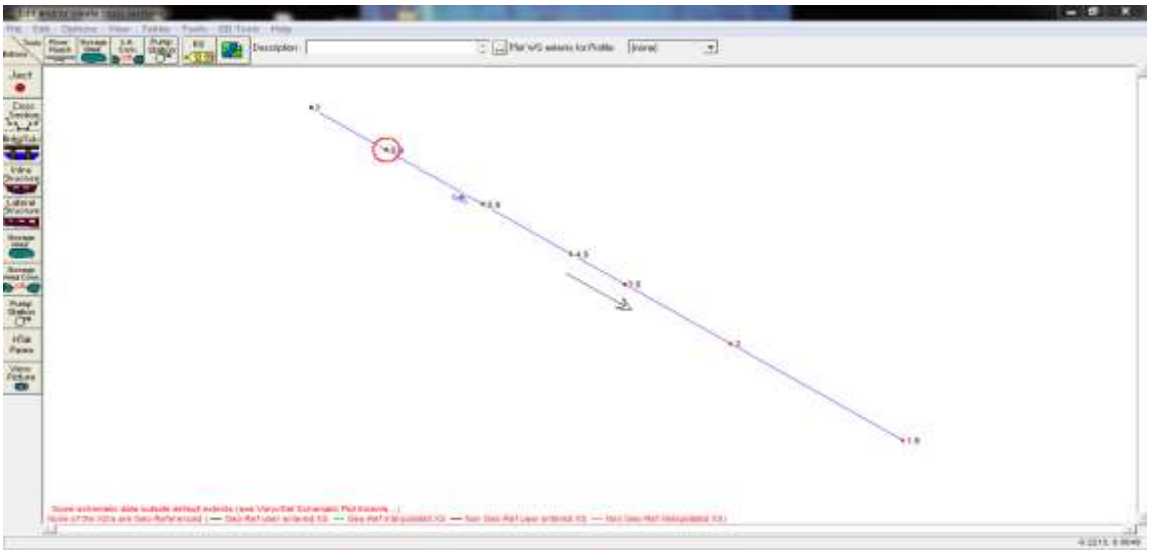

Figure 2: Reach considered on River Omi

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RESULTS AND DISCUSSION

The cross-section shows the respective areas of the points that were considered on the river reach. Table 3 shows the distances between the cross-sections from upstream facing downstream. The downstream cross-section Z_7 has the largest area of 0.726 m^2 with cross-section Z_2 having the smallest area of 0.072 m^2. The discharges at the upstream and downstream across River Omi are 0.460 m^3/s and 0.086 m^3/s. The length of the reach considered and the geometrical data of the culverts used are presented in Table 1 and Table 2.

Table 1: Length of Cross-Sections on River Omi

S/N	Cross-Section	Designation	Distance (m)	Area (m^2)
1	Lade	Z_1 (upstream)	1800	0.220
2	Aba-nla	Z_2 (upstream)	2300	0.072
3	Railway	Z_3 (upstream)	2100	0.138
4	Igisogba	Z_6 (downstream)	4100	0.143
5	Ateere dagilogba	Z_7 (downstream)	0	0.726

Table 2: Culvert Geometrics on River Omi

Culvert Designations	Length (m)	Width (m)	Depth (m)	Wing wall span (m)
Z_1	5.1	4.1	1.25	1.2
Z_2	5.1	4.1	1.25	1.2
Z_3	5.1	4.1	1.25	1.2
Z_6	5.1	4.1	1.25	1.2
Z_7	5.1	4.1	1.25	1.2

The cross-section of a typical submerged culvert at the upstream station is shown in figure 3. This area is highly trapped with sediments due to several flood control plants in the zone, causing obstruction and gradual wearing-off of the culverts, thereby provoking submergence. The datum value of 180 m was obtained which implies that the mean water level and culvert were 0.495 m and 0.48 m respectively.

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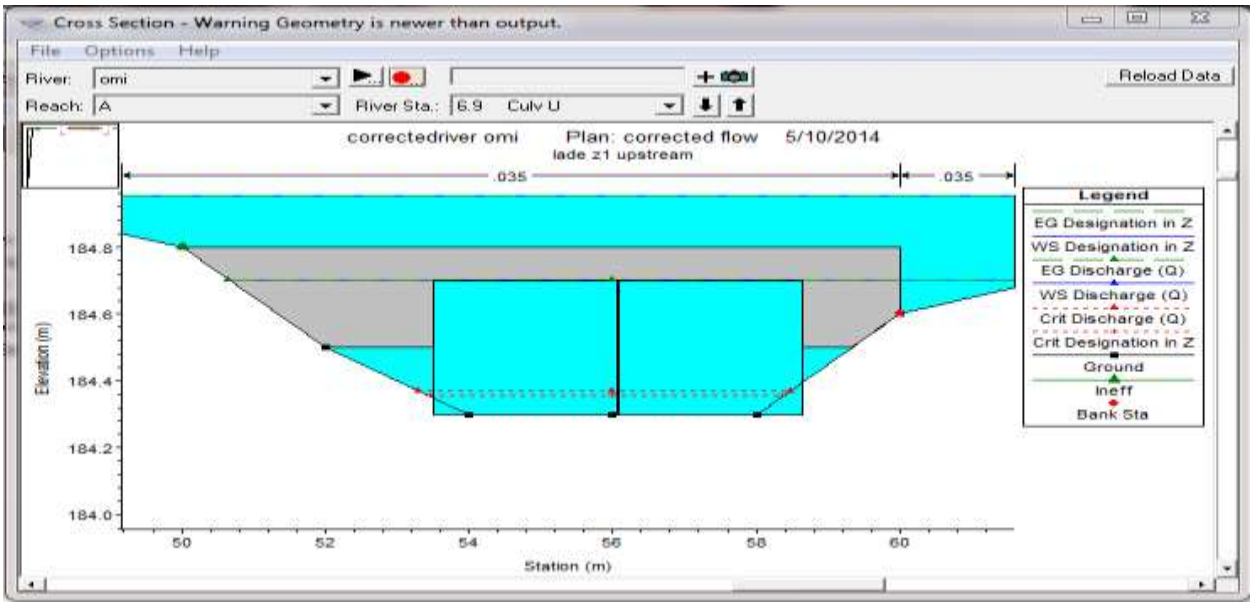

Figure 3: Cross-Section of culvert at Z_1

Figure 4 shows the modified culvert that can effectively accommodate the excess discharge at the upstream. The base of the culvert rests directly at station 52.00 m and at elevation of 184.50 m. The water surface elevation is at 184.81 m and the soffit of the culvert are 184.81m and 186.10 m respectively. This modified culvert can effectively convey water without fear of submergence and dilapidation. The excess discharge at the upstream was due to the expanded flood terrain and land use of the area. The farming activities at the upstream have exposed the area to erosion and increase sediment yield.

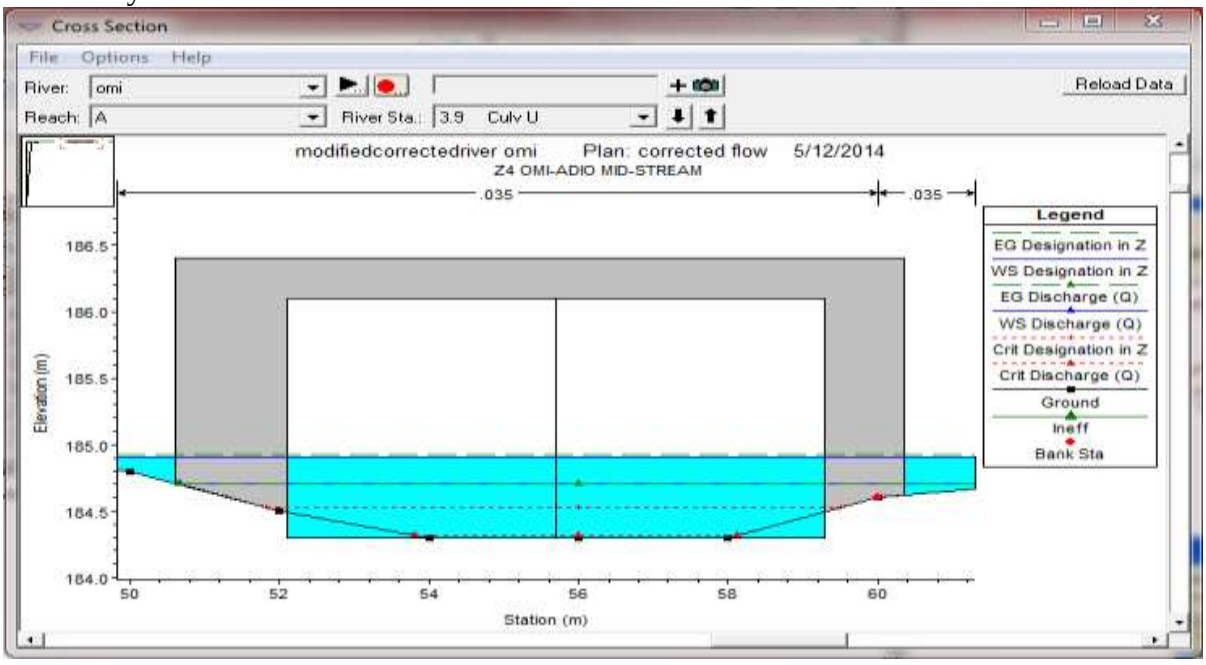

Figure 4: Cross-section of the Proposed Culvert

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CONCLUSIONS AND RECOMMENDATION

Culverts at the upstream of River Omi cannot hold the excess discharge and should be re-designed. HEC-RAS model was used in this study for this purpose. The downstream cross-section Z_7 has the highest discharge of 0.460m^3/s with a suitable culvert. So box culvert spanning 7.2m with a rise of 1.8m will be more appropriate at the upstream to accommodate excess discharge. The modified section is wider and higher than the existing one of (5.1 x 1.25) m. This study provided a baseline to river management and flow management and flood control measure within the area.

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