STUDY AND DESIGN OF FLOOD CONTROL STRUCTURES FOR A MARKET FLOOD SITE IN OWERRI, SOUTHEASTERN NIGERIA

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ABSTRACT
The flood at the Onumiri market, Amakohia in Owerri North Local Government Area of Imo State was investigated. The causes of the flood were identified as poor drainage facilities within the area, blocked drains, dumping of refuse in and around the market arena, indiscriminate erection of structures and lack of maintenance of the existing drains thereby causing the over flow of the channels and the flooding of the adjoining market areas. It therefore, recommends that large sized Culvert be located across the road as well as the expansion of the drains at both flange of the road. Consequently, a trapezoidal channel of bottom width 1.0m and total depth 0.63m should be provided while the approach velocity should not exceed 3.8m/s using the anticipated discharge of 2.8 m^3/s.

Key words: Floods, drainage, blocked drains, overflow, channels, culverts.

INTRODUCTION

Floods can occur as a result of natural and human factors. These factors include high rainfall regime, runoff volumes, soil types, land slopes and poor drainage constructions. Others include blocked drains, improper road construction, lack of maintenance, poor developmental activities and poor farming practices. High rainfall intensities generate higher runoffs that may cause floods Morgan (1995), Madubuike et al, (1999). Development activities do contribute to the generation of overland flow which moves to the adjoining areas to result in to flooding. River and coastal floods occur at the peak of the raining season whereby the rivers overflow their banks with much destructive tendencies. Non provision of drainage facilities tends to encourage flooding as there are no structures to evaluate the surplus water and discharge them at the natural outlets. Structurally defective channels cannot control excessive discharge hence flood occurs. The indiscriminate dumping of refuse on the road obstruct the free flow of runoffs while silting and blocked drains tend to reduce the capacity of the drains and reduce the life span of such structures. The non-provision of these facilities encourages flooding in and around the environment/ adjoining areas (Mbei, 1999). Flood tends to reduce the economic activities as roads are cut and transportation hampered hence movements are discouraged due to poor access roads. Flood encourages road mishap, submerge and destroy buildings, structures and infrastructures as well as overrun homes, farmland and roads.

DESCRIPTION OF ORIE ONUMIRI MARKET, AMAKOHIA

The Orie Onumiri Market is located along Owerri-Orlu road in Amakohia, Owerri North Local Government Area. Amakohia is an autonomous community in Owerri North Local Government and densely populated. It is situated at the rainforest region of Imo State Nigeria, with double peak rainfall regimes that generates large volumes of runoffs that must be removed in order to prevent flooding (Akaedu et al, 2004).

DESIGN REQUIREMENTS

The flood would require the design of suitable channels/drains at both side of the roads which should be able to carry the anticipated/total discharge/runoffs generated from the rainfall events. The runoffs from the rainfall events are usually emptied into the market square thereby flooding the entire market during the raining seasons. The nature of the underlying soil is required to know the nature of the soils for the design of a stable channels and the selection of the side slopes. The time of concentration (Tc) would be required to determine the rainfall intensity (1 mm/hr) associated with the rainfall in the area. The rainfall intensity – duration – frequency curve for Owerri climatic zone will be used. The catchments area that will generate the total discharge will be determined while the slope of the area will be needed for adequate velocity of flow devoid of scouring and erosion of the channel beds. The runoff coefficient (C) will be selected based on the nature of the area and the developmental activities. The concrete channels should be able to provide for a systematic control of flood within the market which should include flood control, flood conveyance and flood discharge.

TABLE 1: WATERSHED DATA

Total catchments area:	35 hectares
Side slope (Z):	2:1
Mannings roughness coefficient:	n = 0.02
Runoff Coefficient:	0.55 (Ministry of works Owerri, 1984).
Velocity Range:	0.75 – 6.0m/s (Ministry of works Owerri, 1984)
Slope of the area:	2% (from survey work)
Soil type:	Sandy Soils (from soil test)
Length of flow:	2000m (from measurement)
storm return period:	10 yr
channel type:	Trapezoidal concrete channel.

DESIGN CONSIDERATIONS:

(a) To provide concrete facilities that can provide systematic control of floods/flows in and around the Onumiri Market in Amakohia.

(b) To provide concrete drains that will collect the flood, convey and discharge the flood to a safest outlet.

(c) To use both the manning and rational formula for the determination of the size and shape of the channel as well as the velocity of flow.

(d) To use a permissible velocity that will be sufficiently high to prevent sedimentation, but not high enough to erode the channel beds and walls.

(e) To use appropriate equations for the determination of the time of concentration (Tc) and the anticipated peak discharge (Qp) from where the selection of the size of the channels/drains.

Consequently, for the time of concentration (Tc); kirpich (1940) equation can be used where

$Tc = 0.0195\ L^{0.77}\ X\ S^{-0.385}$…… (1)

Where

Tc = Time of concentration in minutes

L = The length of flow in meters

S = The slope of the area in percentage.

Using the rainfall – Intensity duration curve for Owerri climatic zone which Amakohia and its environ belongs to and for the return provides of 10 yrs. The time of concentration was obtained as 74 minutes while the rainfall intensity was obtained as 52mm/hr (fig. 1). This rainfall intensity is adequate and can generate a considerable runoffs that can flood the market if not evacuated by the drains. The runoffs or discharges is determined using the rational formula where

$Q_p = 0.0028\ CIA$ …….. (ii)

Hence

Q_p = Peak runoffs/discharge in m^3/s.

C = Runoff coefficient for medium density residential areas: C = 0.55

I = Rainfall intensity obtained from the rainfall intensity – duration – frequency curve for Owerri climatic zone.

A = Area of the water shed that covered the Onumiri market Amakohia.

The anticipated discharge (Q_p) was obtained as $2.8m^3/s$ and with bottom – width ratio of 2 i.e. b/d = 2, a channel width b of 1 metre and depth of flow (d) of 0.5m were designed for the evacuation of a discharge of $2.8m^3/s$ generated from the watershed area. The flow velocity (v) of 3.1 m/s is within the range of 0.75 – 6.0 m/s demanded by ministry of works, Owerri (1984) for drainage designs within Owerri metropolis.

TABLE 2: RUNOFF COEFFICIENTS FOR DIFFERENT AREAS IN OWERRI IMO STATE.

Types of areas	**Runoff Coefficient (c)**
Densely built-up area	0.75
Medium density residential area	0.55
Low density residential area	0.50
Industrial area	0.75
Parks and cemeteries	0.20
Play grounds	0.20
Unimproved land	0.20

Sources: Ministry of works (1984) planning studies for Imo State.

TABLE 3 DESIGN PARAMENTERS

Time of concentration TC:	74 minutes
Rainfall Intensity I:	52 mm/hr
Peak discharge Q_p:	$2.8m^3/s$
Channel bottom width b:	1.0m
Channel water depth d:	0.5m
Freeboard fb:	0.13m
Total depth of channel D:	0.63m
Runoff coefficient	0.55

(a) The bottom width b = 1.0m was acceptable due to the anticipated volume of water from rainfall event which later converge at the market places.

(b) The velocity of flow 3.1m/s was as a result of the slope of the adjoining areas which encourage rapid movement of water towards the market arena. This velocity can be reduced with the provision of drop structures at specific distance.

(c) The concrete drains of b = 1.0m should be installed at both flange of the road leading to the market place to convey the discharge as well as drains of the same size along the Nwaorie river as the safest outlet.

(d) The channels/drains should be desilted regularly in order to prevent channel over flows but provide the capacity to evacuate the hydro dynamic loads associated with heavy rainfalls.

(e) Dumping of refuse and waste materials in and around the market areas should be discouraged to prevent channels blockage.

CONCLUSION

A trapezoidal drain of bottom width b = 1.0m and total depth D = 0.63m was designed for both flange of the roads leading to Onumiri market for the evacuation of flood in and around the Onumiri market square. The channels will provide the effective drainage required, stop over flow of channels and check excessive flooding at the market and other adjoining areas. The flood that move into the market will now be directed towards the natural outlet – the Nwaorie river.

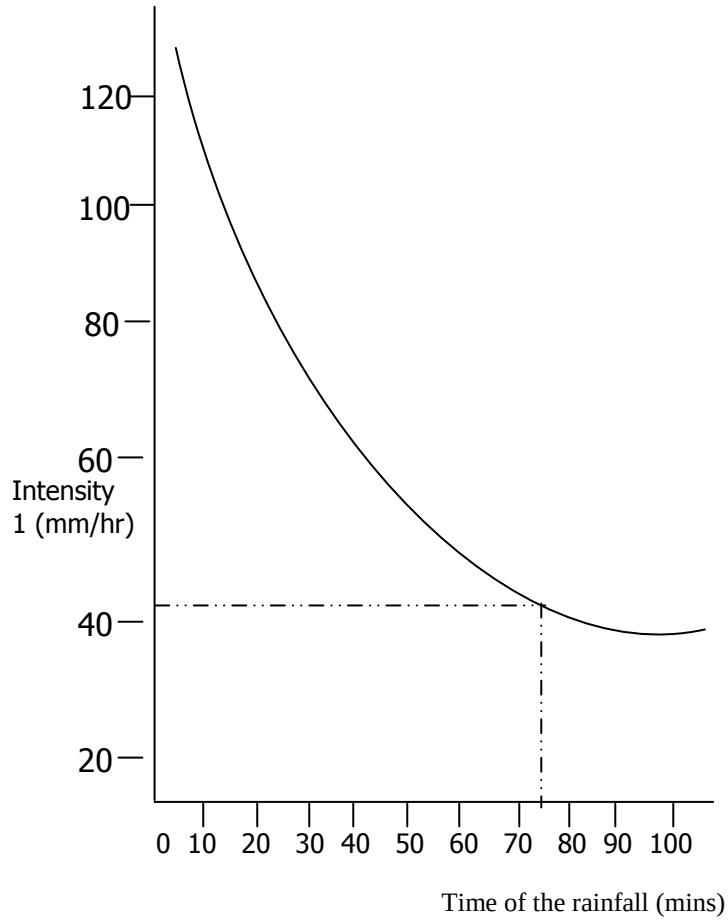

Fig. 1 Rainfall-Intensity – duration Curve.

REFERENCES

Akaedu G. U; Dike L. C. and Duru F. U. (2004): Study and Design of flood control structure for a flood site at Amakohia, Owerri North L.G.A. of Imo State.

Kirpich P. Z. (1940): Time of concentration of small Agricultural water shed, civil Engineering Journal; Vol. 10 pg. 362.

Madubuike C. N. and Idike F. I. (1999): Erosion potentials of rainfall in Imo State of Nigeria. Proceedings of the Nigerian Institution of Agricultural Engineers conferences (NIAE).

Mbei E. O. (1999) flooding of farm roads: causes effect and control Training workshop on Erosion, flood and environment pollution control, Organized by the Nigeria society of Engineers (NSE), Owerri branch.

Ministry of works (1984): planning studies in Imo State. Atlas of Imo State of Nigeria. Department of lands and survey Owerri, Imo State.

Morgan R.P.C. (1995): Soil erosion and Conservation. Longman scientific and Technology studies, Harlow, United Kingdom.