**A TERM PAPER**

**ASSESMENT AND DESIGN OF DRAINAGE FACILITIES AT AFE BABALOLA UNIVERSITY ADO-EKITI**

**BY**

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## 1.0 INTRODUCTION

The drainage facilities are essential part of living in a city or urban area, as they reduce flood damage by carrying water away. It is important that all drainage systems are properly design, constructed and maintained regularly for optimal preservation of engineering infrastructure. There is a consensus today that urban water systems should be approached in an integrated way. Surface water, groundwater, water quality, quantity, and ecology should be looked upon in relation to each other. Thus, the introduction of the concept of sustainability has, in the field of urban water systems among others, led to an increased interest for source control and open drainage of storm water within the urban environment. Looking at the environment around us it shows that ineffective drainage systems are basically associated with poor maintenance, indiscriminate dumping of refuse in drains, erection of building on drainage channels and alignments that inhibit the flow of water which leads to critical environmental hazards.

The Rio declaration and the Agenda 21 from the early 1990’s introduced the concept of long-term sustainability of our environment. One important ingredient in the new approach is that technical, economic and social aspects of the development are handled carefully. The need to provide proper drainage and sanitation facilities is essential to match up with the ever-increasing population growth (Banerjee and Morella, 2011). This is further buttressed by Belete (2011) who expressed that high urban population growth rate also results in drainage system challenges because an increase in population requires a proportionate increase in infrastructure (roads and drainage systems) of which when not properly catered for, the facilities will be imperfect. Also, inadequate integration between road and urban storm water drainage can be attributed to natural causes such as intense rainfall, flat topography and poor soil infiltration or man-made causes such as improperly laid and graded street, poor and inefficient drainage facilities that aggravate the flooding problem. Urban environments in Nigeria are faced with myriad of issues regarding poor drainage systems and water tight structures which are the major causes of flooding (Belete, 2011). Urban flooding which is the inundation of land or property in a built environment, particularly in more crowded areas are caused by rainfall overwhelming the capacity of drainage systems. Although this is sometimes caused by events such as flash flooding (Tucci, 2001).

Urban flooding is a condition characterized by its repetitive and systemic impacts on communities whether or not the affected communities are located within floodplains or near any body of water (CNT, 2013). Sule (2001) described Lagos, Calabar and Ibadan as cities where houses are constructed directly on drain channels and that this practice has resulted to blockage of storm drains and consequently leading to overflow and flooding of streets.

Also, poor drainage systems have caused tremendous environmental challenges in major cities in Nigeria. These challenges are basically associated with poor maintenance of drainage system and flood which eventually leads to environmental hazards. Some places were flooded, making the roads practically impassable for motorists. In many instances, torrential rainfall literally submerged the cities, halting human and vehicular activities thereby forcing residents to stay indoors as a preemptive measure against human disaster.

## 2.0 DRAINAGE SYSTEM EVALUATION

A drainage system is the pattern formed by the streams, rivers, and lakes in a particular drainage basin. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land. A drainage basin is the topographic region from which a stream receives runoff, through flow, and groundwater flow. The number, size, and shape of the drainage basins found in an area vary and the larger the topographic map, the more information on the drainage basin is available.The drainage system is an essential part of living in a city or urban area, as it reduces flood damage by carrying water away. Conventional drainage systems are designed to achieve a single objective — flood control during large, infrequent storms. This objective is met by conveying and or detaining peak runoff from large, infrequent storms. Drainage systems designed to meet a single flood control objective fail to address the environmental effects of increases in runoff volume and velocity caused by development, as well as flow peaks. Increased runoff from small, frequent storms erodes urban streams and washes eroded sediment and other constituents from the urban landscape into downstream receiving waters, often damaging adjoining property and impairing their use by people and wildlife in the environment.

## 2.1 Importance of Drainage

A road drainage system must satisfy two main criteria if it is to be effective throughout its design life. It must allow for a minimum of disturbance of the natural drainage pattern. It must drain surface and subsurface water away from the roadway and dissipate it in a way that prevents excessive collection of water in unstable areas and subsequent downstream erosion.

It is essential that adequate provision is made for road drainage to ensure that a road pavement performs satisfactorily. The main functions of a road drainage system are: • To prevent flooding of the road and ponding on the road surface

* To protect the bearing capacity of the pavement and the subgrade material
* To avoid the erosion of side slopes.

## 2.2 Types of Drainage

The type of road drainage which is selected for a particular road will depend on such factors as to whether it is a rural or an urban road, or if it is in cut or fill and also on groundwater conditions. Surface drainage is the removal of water that collects on the land surface. A surface drainage system consists of shallow ditches and should include land smoothing or land grading. This type of system is suitable for all slowly permeable soils and for soils with fragipans or clay subsoils. A trench drain (also channel drain, line drain, slot drain, linear drain or strip drain) is a specific type of floor drain containing a dominant trough- or channel-shaped body. It is used for the rapid evacuation of surface water or for the containment of utility lines or chemical spills. The principal types of drainage are Pipe (positive) drain, French drain and Open drain. Pipe (positive) drain: A piped positive drain is normally associated with an urban situation and is used in conjunction with gullies and kerbs/footways. It may also be used in some rural embankment situations where it is deemed important that water from the road and hard shoulder should not be allowed to drain onto the embankment. Piped systems with gullies require regular maintenance and while in many instances these systems are cleaned annually the data received suggests that the frequency of maintenance is generally considered inadequate

 French drain: A French drain is the most commonly used system on newly constructed roads in rural areas. Open jointed pipes are laid in a trench which is backfilled with a porous material. French drains are a useful method of providing both surface water and subgrade drainage where space is limited. French drains are used extensively on sections of the national network and to a limited extent on non-national roads. Maintenance levels are low and this may affect the long-term performance. In most instances maintenance is carried out as problems manifest themselves, with few counties having an annual maintenance programme.

Open drain: Open drains facilitate the early visual detection of blockages but their use may be restricted by the lack of roadside space, safety considerations and the risk that they may be closed in by agricultural machinery. Open drains are the most common form of road drainage on rural national and non- national roads. Open drains have the advantage of being easily inspected for blockages and are also effective at draining the road sub grade provided the drain flows to an adequate outfall. Open drains are generally, but not always, within the road limits. In circumstances where open drains are on private property the Authority’s powers under the Roads Act should be exercised to ensure that drainage is not interfered with. Open drains are used to drain surface water and to act as interceptors for seepage water, including sub-soil water. The use of open drains may be restricted for reasons of safety and of maintenance. They are often used, however, at the bottom of embankments and as intercepting channels at the tops of cuttings. Open drains should be located a suitable distance from the edge of the road pavement to ensure that water does not seep back into the road foundation.

## 2.3 Trenchless Drain

Trenchless drain is a composite of absorption field and grass cover aligned on both sides of a road. The concept is centered on the provision of a trench backfilled with relatively permeable material. The arrangement provides a wider surface area for water infiltration. The backfill is either sand or gravel. The grass cover provides the foliage for interception of rain drop, stems and leaves introduce greater roughness while the roots provide greater infiltration channels. The cover, generally, binds the superficial soil particles, restrains soil movement, reduces its erodibility and increases the shear strength through a matrix of tensile fibers. It has been observed that a 2m × 2m trench backfilled with sand per unit length drains water 5 times faster than a 2m wide grassed surface or 20 times faster than the bare surface.

The design of a trenchless drain assumes that only the road wash flows towards the road sides and flow down slope is prevented by the relatively flat nature of the terrain.

No flow from outside of the road is considered

Equating the volume of inflow to the drain (*Q*) and the infiltration capacity of the composite drain (*F*), the theoretical width (*wt*) of the drain was obtained [2].

Thus, for a square drain:

*Q* = *k*11 (*wr* + *wt*) ………. (1)

*F* = *k*2 3 *wt k ………………* (2)

*Wt* = *k*11 *w*r /(3*k*2 *kTn* –*k*11) … (3)

where, *wt* = theoretical width of a square drain

1 = rainfall intensity

*Wr* = design road width

*K*1, *k*2 = coefficients representing losses, generally < 1 *T* = time factor

*n* = standing time of water as a pool *k* = hydraulic conductivity of in situ soil.

For optimal design or at limiting equilibrium condition the rate at which water flows into the drain is the same as the rate it i.e. *n* = 0, and the equation becomes

*Wt* = *k*11 *wr* /(3*k*2 *k* –*k*11) …………… (4)

The factors *T*, *k*1, *k*2 are site dependent and can be established empirically. Ideally, where there are no water losses, *k*1 = *k*2 = 1

i.e. *Wt* = 1 *wr* /(3*k* –1) ………………...(5)

*Wt* in apparently the hypothetical width of the drain and is related to the effective design width *Wd* by

*Wt* =*Wd η …………………………………* (6)

where *η* is effective area factor = porosity of backfill

*Wd* = 1 *wr* /( *η* (3*k* –1) ………………..(7) Sketch designs are shown in Figure 1.

**Figure 1: Section of hypothetical design of a trenchless drainage system on a road section**

## 2.4 Ground Topography and Geomorphology

Natural water courses should always be retained and drainage works should be designed to follow the natural surface depressions as closely as possible. The natural waterway morphology should also be retained or mimicked where possible in the design. This will minimize the amount of excavation required during construction.

In some cases, the depth of the drain can be reduced by offsetting the drain from the natural watercourse. This will be possible only if there's enough space available in the reserve and the inlet connections can still be made.

## 2.5 Drain Location

When designing drainage pipelines, the design must be extended to cross any road or proposed road widening that's adjacent to the development. This ensures any existing or proposed services within the road reserves are known and the proposed drainage works can cross these services. As well as generally following the natural watercourse alignment, drains should, as far as practicable, be designed to follow easements or reserves intended for drainage purposes. Easements and reserves must be sized to cover the width of the drain as well as provide for access, construction and maintenance.

Construction and maintenance requirements are particularly important considerations when designing channel or waterway works. Relevant considerations include:

the maximum slope and height of the grassed batters

* whether trucks require access to the channel invert
* the location of inlets and roads
* whether there are limitations on the use of certain construction techniques (when adding to, or duplicating existing drains in built-up areas.
* ground conditions
* the distance from the proposed alignment to any existing services (particularly if there are any issues with side loading effects during excavation)
* the location of overhead power lines and the width of streets

Location of an underground drain within the pavement area of a road is acceptable if it's not practical to locate the pipeline outside the pavement area. Possible limitations on the use of certain construction techniques need to be considered when selecting an underground drain alignment.

This is particularly the case when adding to, or duplicating existing drains in built-up areas.

## 2.6 Surface Obstructions

Surface obstructions such as buildings, electricity supplier poles, native vegetation or large trees etc. may affect the proposed alignment of the drain. These should be located during the initial survey and inspection of the site. If the proposed drain location can't avoid or closely approaches the obstruction, it'll be necessary to contact the owner, local council or relevant authority. The designer should compare the construction costs to either avoid, or where feasible, relocate the obstruction before deciding on the final route of the drain.

Existing bridges or culverts can also influence the design. These must be checked to ensure they're capable of coping with the additional discharge from the proposed drain. The alignment and capacity of the existing structure may need to be improved during construction if necessary.

## 2.7 Design Depth

Some factors that influence the drain depth include:

* the hydraulic considerations
* the provision of space above a drain for other services
* ground conditions
* underground obstructions
* the size and depth of existing culverts and bridges

the ability to adequately service upstream catchment properties likely to be developed in the future

* the provision of sufficient grade for the future downstream extension of the pipeline
* sufficient cover for future road grading and pavement depth

Where possible, the drain should be designed as high as possible to minimize construction costs. The minimum cover over underground pipe drains is 850 millimeters. However, less clearance is permissible for short lengths where justified by local circumstances.

The cover over the pipe is to be considered to ensure it does not compromise pavement design or location of other services.

## 2.8 Ground Conditions

Ground conditions affect the design depth of both underground pipes and channels. If clay or soft material overlies rock, it may be necessary to install a larger drain with a flatter grade at a higher level or change the cross-sectional shape to reduce the amount of rock excavation.

Where surface drains are to be located in areas where a high-water table exists, the channel should be designed at a depth to minimize uplift forces on any lining and reduce de-watering problems during construction. The use of a "natural" open waterway rather than an artificially lined channel will always be preferred.

Designers should consult an experienced geo-technical consultant to determine suitability of proposed works to the geo-technical conditions of the site. Sufficient test pits and/or bore samples should be taken to determine ground water levels and rock depths etc. prior to commencement of design. Geo-technical consultants may provide advice for construction techniques or application of materials standards to lower construction costs.

## 2.9 Environmental Considerations

Wherever possible the design and alignment of underground and surface drainage should avoid or minimize the impact on existing environmental values. This includes direct impacts such as tree removal and habitat disturbance as well as ecological process issues, such as changes in water regimes for wetlands or grasslands. The following issues should be considered:

* impact on remnant indigenous trees and shrubs
* impact on remnant native grasslands or wetlands
* impact on native fauna, including local and migratory species

impact on listed threatened species

* potential to encourage weed invasion

## 2.10 Culture and Heritage Assets

A heritage place is a specific area or site, perhaps a large area such as a whole region or landscape, or a small are such as a feature or a building, which is valued by people for its natural and/or cultural heritage significance.

The community places a high value on the significance of indigenous and non-indigenous places and sites. In turn, communities place expectations on all levels of government to protect our natural and cultural heritage. In planning for the future, it's important to ensure all elements of significance are protected.

Drainage design should always consider the impact on cultural and heritage assets. The developer must undertake all necessary investigations to determine the presence of any assets and ensure the drain design protects, preserves and promotes cultural and heritage assets.

## 3.0 MATERIALS AND METHODOLOGY

**3.1 Brief history of ABUAD**

Afe Babalola University, Ado-Ekiti (ABUAD), a Federal Government-licensed, Non-Profit Private University is a model which is unique in many ways. It is located on 130 hectares of land at an altitude of over 1500 feet above sea level which *ipso facto*provides cool and ideal climate of learning and sports activities. The area of study is 7.670929°N 5.307051°E.

**3.2 Process Involved in the Construction of a Drainage**

The process involved in the construction of drainage facilities includes:

1. The clearing of the environment was drainage would be constructed.
2. The excavation or digging of the drainage channel.
3. The placement of reinforcement bars in the excavated channel.
4. The placing or pouring of concrete aggregates (casting) on the base of the drainage channel.
5. The construction of the frame work for the drainage wall.
6. The placing or pouring of concrete aggregates (casting) inside the frame work to construct the drainage wall.
7. After the concrete has dried up then the frame work is removes.

**3.3 Drainage Designs Problems**

Urban drainage system issues are also generated by improper design of these systems. This is

attributed to the variance created in rainfall distribution patterns faced by the developing countries as a result of global warming (Silveira, 2001). Also, roof catchment methods of rain water collection should be encouraged to reduce peak flows of runoff that should have entered this drainage. There is so much reliance on hydrological data in determining the drainage challenges. Vital information and proper data collection such as water quality of runoff and sediments transport

should not be neglected. This could improve the design and sustainability of these drainage

channels.

**3.4 URBAN Drainage Planning**

In the study areas, the alteration in the planning has led to buildings being erected on drainage

channel and path thereby increasing storm water problems. Also, it has left little or no escape routes for flood water thereby making these structures ineffective and insufficient. Drainage planning in the beginning is essentially a sure way to abate flooding issues. Secondly, due to alteration in urban planning, there is need for a review of the designs of the various drainage networks already in use. The policy should henceforth mandate that only houses which are in accordance with already laid policies which promote well-being and sustainability of the city be approved. Three broad categories with preventive maintenance, all the strategies can be said to have been arranged in ascending order of effectiveness (Adeyeri, 1995). It is believed that if as these four functions are thoroughly and rigorously pursued the identified problems shall be a thing of the past.

**4.0 DISCUSSION AND FINDING**

from the research, it was discovered most of the drains were free from waste materials due to daily maintenance. The culvert leading to the Afe Babalola University Multisystem Teaching Hospital is filled with weed which can resist easy flow of water.

**4.1 design of drainage channels or ditches for roads and buildings**

 Estimation of Peak Flows can be done using the Rational formula, Cook's method, Curve Number method, Soil Conservation Service method. Drainage coefficients (to be treated later) are at times used in the tropics used in the tropics especially in flat areas and where peak storm runoff would require excessively large channels and culverts.

**The Rational Formula**

* This may not apply locally because of high slopes.
* It states that: qp = (CIA)/360 • where qp is the peak flow (m3 /s);
* C is dimensionless runoff coefficient;
* I is the rainfall intensity for a given return period. Return period is the average number of
* years within which a given rainfall event will be expected to occur at least once.
* A is the area of catchment (ha).

**4.2 ROAD and Drainage**

Roads improvement in Nigeria shall involve the reconstruction or surfacing of important sections of the road network with priority being given to those sections with severe distress and the sections which provide important linkages or constitute critical bottlenecks in the urban transportation system. The vertical and horizontal alignments of some roads shall be changed in order to meet the service requirements. Structural improvements and provision of road furniture and amenities shall be included in the development plan. Pavement evaluation study shall be carried out and a road database created for Nigerian roads. This will aid the maintenance and management of the road. The storm water drainage improvement shall involve the provision – or upgrading of primary drainage systems within the state so that major flooding experience in the past in the various locations could be avoided.

**5.0 CONCLUSIONS AND RECOMMENDATIONS**

**5.1 Conclusion**

The design must be done consciously by professional Engineers using code of practice,

construction must be done with quality materials and workmanship in line with professional ethics and standards. The overall management of the construction of drainage facilities should be done in conformity with environmental sustainability guidelines. This can be achieved through sanitary approach which involves more of community involvement in actualizing the goals of proper and effective sanitation process.

From the study, it can be concluded that drainage at Afe Babalola University are adequate to prevent any flooding. Regular cleaning and maintenance of the drainage system should continue and stiff penalties should be implemented to people who dump refuse into the drainage.

**5.2 Recommendation**

In order to ensure a sustainable and efficient drainage system, the following recommendations are made:

1. Nigerian Society of Engineers (abuad chapter), department of civil engineers and the department of works must ensure that proper procedures are followed in school projects to avoid cost overrun and time extension in drainage related contracts.
2. Routine maintenance must be done at intervals.
3. The master plan must be adhered to strictly
4. Penalties should be placed for any person littering the environment
5. Awareness should be made for improper refuse dumping

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