Thematics Journal of Applied Sciences

ISSN no. 2277-3037
Vol 10 No 11 (2021)

DRAIN CONSTRUCTION INCONGRUITIES BY GHANAIAN CONTRACTORS – Case Study at Kade in the Eastern Region of Ghana, Africa.

ISAAC ODOI DANQUAH

diok1982@yahoo.com

Water Resources Engineer, Goldrain Mountain Company Limited, Koforidua – E/R, Ghana.

Abstract

With growth in population, urbanization and national development, impervious surfaces will continue to be created hence the resultant rate of runoff generation after rainfall within a catchment area. This generated runoffs are channeled downstream of the catchment area by drains of different sizes. There is the need for drains to be of adequate capacity to be able to carry all these runoffs to avoid overland flow causing flooding and ending on roads and homes. Drain design and construction needs experienced engineers in its executing. This is not seen in Kade, the study area, rural and most areas within Ghana as contracts are given to inexperienced contractors to execute. This research work therefore sorts to investigate drain construction discrepancies within the municipality. Research findings indicates poor drain design, poor siting and construction. Drains of inadequate capacity to carry runoffs is also identified as a problem. Most of the constructed drains are filled with dug soils, bitumen, stones and chippings used in the construction process filling the drain and reducing drain capacity by half. Runoffs therefore settle at points within the drain and unable to drain downstream. Slopes of drain banks is also too steep resulting in washing of soils into the drains during rainstorms after constructions. No bioengineering or vegetation cover to cater for eroding of soils into the drains. Research findings got some road areas having stormwater running from drains unto the roads together with debris, refuse, plastics, weeds which have been accumulated in the drains during the dry season. Most of the drains which have collected sewage water produces odors and serves as breeding grounds for mosquitoes and frogs and other animals. Its therefore of utmost importance that, road construction contracts be awarded to good drainage engineers and not just anyone else who is politically affiliated who will just contract people to do a shoddy work. Drains should be expected by experts to meet standards before paying contractors. Investigations revealed that no proper continuous repairs is done on drains and once they are constructed, that is all and this is shortfall. Investigations of drain capacity against coverage by weeds, soil, water, sewage, debris indicated that, drain with sewage water is 20%, some drains had 100% soil coverage hence unable to see the drains, with soil and water is 70%, drain breakages is 23%, with soil at the banks of drains is 45%, bad connection to culverts is 3%, drains capacity with soil only is 50% and drains with stormwater is 32% in capacity. This effect results in drain overflow during storms unto roads resulting in floods and splashing.

Key Words: Drain, urbanization, catchment, runoff, Kwaebibirim, stormwater, floods, bioengineering, watercourse, Environmental Protection Agency.

ISSN no. 2277-3037
Vol 10 No 11 (2021)

1 Introduction

1.1 Drain Concept

Drains of varied capacities are constructed to allow the exit for rain water from roads and impervious surfaces. There are two types of drains namely open drains and closed drains depending on designers intentions, motive and purpose to be achieved. For the out let of house hold water, an open drain is constructed in front of the house, which takes away the house hold water away to a long distance. For drains on roads such as Kade road, it's to collect all runoffs from the road and move it downstream into a drain of larger capacity or into a river or stream. Drains construction needs expertise of varied experience as there is the need for vigorous calculation towards the design and construction. Calculations such as the quantity of runoffs generated and collected within the catchment, or on the road, nature of catchment area (pervious or impervious), infiltration rate, nature of soil, choosing the type of drain and designing the drain capacity to collect generated runoffs. Drains for collecting runoffs from roads should be of adequate capacity to collect all runoffs generated on the roads during storms to reduce friction in order to avoid accident. It is suggested that adequate surface drainage, combined with appropriate internal drainage, is the most advantageous solution to the problem of water buildup beneath a roadway. Water buildup on roads results in floods on roads and this may cause accidents hence the need for the collection of all generated runoffs on roads into an appropriate drain of required capacity to be channeled downstream. Road surface drainage deals with the drainage of stormwater runoff from the road surface and the surfaces adjacent to the road formation. Several elements can be used to intercept or capture this runoff and facilitate its safe discharge to an appropriate receiving location. These elements include:

- Kerb and channel
- Edge and median drainage
- Table drains and blocks
- Diversion drains and blocks
- Batter drains
- Catch drains and banks
- Drainage pits
- Pipe networks (DTMR, 2019).

After falling onto road surfaces, rainfall runoff drains to the lowest point through the drain of adequate capacity to carry the runoff and in moving across the road surface forms a layer of water of varying thickness. This layer of varying thickness if not collected on time using the drain of required capacity which will not result in overland flow will pose treat to motorist using the roads.

Splash and heavy spray are thrown up by moving vehicles, reducing visibility, while the water on the pavement reduces friction between the tyres and road surface (DTMR, 2019).

Stormwater drainage and sewerage are part of the essential infrastructure of a modern city. In Kade, the same systems are

ISSN no. 2277-3037
Vol 10 No 11 (2021)

provided for the collection and disposal of stormwater and sewage. Stormwater systems and sewage systems for the collection of runoff and sewage water are the same as drains are not separated hence ends up collected in road drains, some getting impounded resulting in the breeding of mosquitoes.

In Ghana, life and property are from time to time under the threat of flooding due to heavy rainfall. Rainfall distribution is seldom uniform spatially and temporally and remarkable extremes in storm rainfall are also experienced. Such heavy rainfall, sometimes coupled with high sea levels associated with storm surges during the passage of tropical cyclones, can cause flooding.

Apart from natural causes, human activities can also influence the prevalence of heavy buildups of water on our roads. Examples are changes in land use resulting in increase in runoff and depletion of flood storage; blockage of natural drainage systems by refuse, agricultural wastes or silt arising from both natural erosion and construction activities; indiscriminate refuse filling; lack of comprehensive maintenance of natural watercourses due to land access problems and lack of maintenance for our drains.

Excessive water on the pavement, whether ponded or flowing, can represent a real risk of aquaplaning or the build-up of a layer of water between the vehicle tyres and the road surface, which leads to a total loss of grip or control. While part of road surface drainage, aquaplaning is a critically important aspect of road surface drainage and is discussed within its own section (DTMR, 2019).

1.2 Environmental impacts of Drains Siting

1.2.1 Aesthetics/Landscape

All the drainage works should be designed to blend in with the environment. Special attention should be paid to the aesthetic aspects of the structures and landscaping works. Landscape architect of the relevant office in hydrological service department (HSD) may be consulted for advice on landscape treatment. There must be collaboration with the Agricultural sector especially the floweriest and those who deal with green grasses to beautify the surroundings of the drains.

1.2.2 Natural Streams and Rivers

Natural streams and rivers are good habitats supporting a variety of wildlife and may have important ecological functions and carry high aesthetic and landscape values Construction works should be restrained to minimize possible disturbance to the ecosystem (DSD, 2018). For projects that may affect natural streams or rivers, the project proponents should ensure that comments and advice received from hydrological service department and Ghana Highway Authority, Water Resources Commission and appropriate departments are incorporated

ISSN no. 2277-3037
Vol 10 No 11 (2021)

into the planning, design and construction of the projects as far as practicable (DSD, 2018). If there is vegetation or landscaping features forming part of the mitigation requirements, the project proponent should also identify the maintenance party during the design stage.

1.2.3 Environmental Assessment

The necessity for and the extent of a Project Profile and an Environmental Impact Assessment (EIA) for stormwater drainage projects should be determined in accordance with the prevailing Government procedures by both the drainage contractor and Environmental Protection Agency (EPA- Ghana). The drain construction should be user friendly both the motorist and pedestrian. Most drains within the study area are not user friendly as they have been polluted to a higher degree with sewages from homes, refuse from homes and collected sand. Almost all (99%) drains in Kade are open drains and making them non – user friendly. The impact on the environment of most drains is very bad.

In addition to the air, noise, dust and water aspects which are usually considered for most civil engineering works, issues such as dredging and disposal of contaminated mud and the impact of large-scale drainage works on the ecology of the surrounding areas should also require detailed assessment. Mitigating measures such as wetland compensation should be devised accordingly to check the impact on the environment (DSD, 2018).

1.2.4 Environmental Nuisances

It is well knowing that stormwater drainage systems in Kade under certain circumstances has been contaminated by different pollution sources including sewage through expedient connections and hence giving rise to odour nuisance to the municipality. Siltation and odour problems should therefore be considered at planning, design, and construction and operation stages of stormwater drainage system, in particular where it is within the tidal zone or where significant pollution, such as discharge of livestock's waste into watercourses, channels etc., is identified (DSD, 2018).

Once expedient connection or pollution source is found in the stormwater drainage system, it should be reported to Hydrological Service Department or Ghana Highway Authority and relevant maintenance parties of the stormwater drainage system. Where a significant pollution source is identified, remediation at source is usually the most effective solution to curb the pollution impacts. However this may not be achieved by the relevant authorities within a short period (DSD, 2018).

2 Study Area

The study area for this research work is Kade which is capital town of the Kwaebibirem Municipal Assembly. Kwaebibirem Municipal District is one of the thirty – three districts in Eastern Region – Ghana. It was originally created as an ordinary district

ISSN no. 2277-3037
Vol 10 No 11 (2021)

assembly in 1988 when it was known as Kwaebibirem District, which was created from the former West Akim District Council. The southern part of the district was split off to create Denkyembour district 2012, thus the remaining part retained as Kwaebibirem District. It was then elevated to Municipal status in 2018 and now known as Kwaebibirem Municipal Assembly. Kade has a population of 16,542 according to the 2013 population census in Ghana and with town at an elevation of 131m above sea level. The main occupation of the town is farming of African oil palm *(Elaeis guineensis)* to obtain oil palms and palm nuts for palm oil and palm kernel of various amounts (**Plate 2a)**. The African oil palm is also used to produce palm wine and akpeteshie which is nationally consumed. Other farm producing crops includes cocoa, plantain, cocoyam, yam, pepper, cassava and other farm produce. **Fig. 1** below shows the map of the study area.

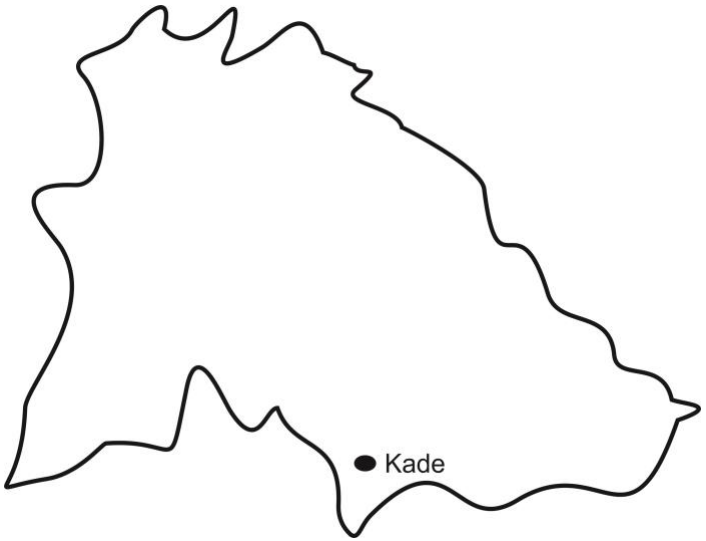

Fig. 1: Map of Kwaebibirem Municipal Assembly

3 RESULTS AND DISCUSSIONS

3.1 Drain designers and Construction ability

Drain design and construction awarding contracts is a major problem in the country Ghana because of corruption and greediness on the part of Ghanaians. Contract are awarded based on political backgrounds and affiliation and not on knowledge and experience in the field of drainage engineering. Unqualified people or individuals are awarded these contracts and they also just hire people with little or no experience to execute the contract. This results in the construction of drains with all kinds of shortfalls. The shortfalls includes drains of inadequate capacity, drains filled with soil, sand and chippings

ISSN no. 2277-3037
Vol 10 No 11 (2021)

reducing drain capacity by half blocking runoffs during storms, taking away soils and sands forming banks from the drain environment after construction etc.

3.2 Drain issues after construction

90% drains constructed by road contractors in Ghana have issue with appropriateness and suitability in meeting standards by taking stormwater and road runoffs downstream. Drain construction requires feasibility studies, drain design and then construction. Looking at drains constructed during road constructions, it gives a clear indication that road contractors are much interested in getting the road constructed and then their money. Drains constructed in Ghana lacks aesthetic ability hence taking the road beauty away. Most of the constructed drains in Ghana are opened drains with all kinds of debris, refuse, soil, weeds and sewage water collected in them after construction. The collected sewage points become breeding grounds for mosquitoes and frogs and all kinds of animals lacking beauty in all aspect. The nature of drains after construction is not attractive at all in Ghana making the environment untidy and not welcoming.

In every country, road construction, drain construction and addition of bioengineering within the banks and the environment of drains and roads makes such areas and beautiful to see. This cannot be seen in the case of Ghana (**Plate 3a**).

Plate 3a: Drain filled with soil, weeds

The opened drains construction in Ghana is making the country unclean and opened for uncalled attitudes and behaviour from citizens such as throwing home refuse into drains, channeling home sewage systems to drains, Collecting stations refuse and depositing them into drains and sweeping stores surroundings and depositing them into drains. There is the need for the construction of closed drains in Ghana to avoid this uncalled for behaviour from Ghanaians.

The uncaring nature of Ghanaians and bad attitudes is also playing a role in the bad nature of drains within the country. Most people think such facilities are for the government and hence no need to partake and collaborate in keeping it neat and

ISSN no. 2277-3037
Vol 10 No 11 (2021)

beautiful to beautify the environment for all and the future generation. Than Ghana Highway Authority and Hydrological Service needs to enforce laws in the operation and maintenance of drains so that the after use will be meaningful for now and the future towards tourist attraction like Dubai **(Plate 3b).**

Plate 3b: Country with closed and buried drains improving the aesthetic nature of the roads.

3.3 Drain usage after construction

Drain usage in Ghana is very poor by all (within the communities, by road users, at the car parks, at the stations, at the malls, at the restaurants, infront of homes, at private and government institutions etc.). Effective use of drains after construction is for the long usage of the facility as generation come and go through monitoring and maintenance. This is not the situation in Ghana and hence Kade as drain usage is very poor as all kinds of waste materials (debris, refuse, sewage water, soapy waters obtained from washing cloths and plates, used plastics, soils, eroded sands etc) are deposited in drains. This has reduced most drain capacity within the municipal as some are blocked totally preventing stormwater runoffs being collected by drains and channeled downstream. Such storm waters therefore find themselves on the roads during storms as they build up to several degrees causing floods on the road and posing threats to vehicles and drivers.

Another problem associated with drain usage after construction is the collection of refuse from homes and lorry stations and depositing them in drains during storms. This results in the blockage of drains as such rubbish or refuse and channeled as the rate of displacement per unit time is high. But once velocity of moving stormwater decreases as the rains stops, all these deposited refuse get collected along the way. Continues practice of this behaviour results in the accumulation of the debris and blockage of the drain and even growth of plants and weeds in the drain reducing drain capacity or deactivating the use of the drain as depicted in **Plate 3c**. Most of these drains are drains which were constructed less than 6months ago indicating the shoddy work done by contractors and engineers employed to construct roads and drains in Kade.

ISSN no. 2277-3037
Vol 10 No 11 (2021)

Plate 3c: Deactivated drain use as weeds continues to grow in drain with settled water

Plate 3d: Eroded soils and debris into drain

Plate 3d gives a clear indication of poor drain usage as soil has been eroded into the drain reducing drain capacity, blocking stormwater moving downstream and the resultant collection of stormwater in the drain. This collected water is expected to serve as breeding grounds for mosquitoes and frogs hence contracting of malaria if this drain is sited infront of a house.

3.4 Hydrology

3.4.1 Storm drains designs

The rational method is the most common method used for the design of storm drains when it should be limited to systems with drainage area of 200acres. Drainage pumping stations require the development of a runoff hydrographs. Other hydrological procedures includes the Soil Conservation Service Curve Number method.

The rational equation is given as follows;

$$Q = CIA \quad = (\sum CA)\, \mathrm{I}$$

Where,

Q = Peak runoff (cfs)

C = Runoff coefficient

I = Rainfall Intensity (inches/hr.)

A = Catchment Area (acres)

This is the equation which needs to be used by contractors to evaluate for the stormwater discharge into a catchment area

ISSN no. 2277-3037
Vol 10 No 11 (2021)

and hence into a drain. This become purposeful for the over – sizing of the drain to receive stormwater from the catchment area to avoid overland flow. This is not seen in the case of road contractors and drainage engineers in Kade municipal as drains are just constructed not to meet demand of the municipal in terms of stormwater or aesthetically but just for the money.

The runoff coefficient is a dimensionless value representing characteristics of the catchment area becomes runoff. Coefficient selection is based on land use and soil condition of the drainage areas associated with the C value. The runoff coefficient, C is given by

$$C = \frac{A_1C_1 + A_2C_2 + A_3C_3 \ldots\ldots + A_nC_n}{A_1 + A_2 + A_3 + \cdots + A_n}$$

Rainfall intensity (I) is an average rainfall intensity for a duration equal to the time of concentration for a select reoccurrence interval. Rainfall intensity is the intensity of rainfall in inches per hour for a duration equal to the time of concentration. Intensity is a rate of rainfall over an interval of time such that intensity (I) multiplied by duration is equal to total amount of rain. Once can ask whether this equation for drain designs is still being used by drain contractors in Ghana.

3.5 Drain maintenance after construction

The longevity, ability, functionality and sustainability of any facility or structure depends on monitoring and maintenance plan. Ghanaians maintenance ability for government structures and projects is very poor and drains in Kade municipal is no exception. All road drains constructed within the Municipal all lack good monitoring and maintenance plan. This needs to be looked at and worked on if the Municipal wants to be seen as big city in the future to come.

For effective monitoring, there is the need for a department like Hydrological service department and Ghana Highway Authority to have a locally or municipally formed body to be monitoring and maintaining the drains for longevity. With this in place, bad practices of throwing debris, refuse and rubbish into drains will be avoided. Contractual works involving road construction should be full of visibility studies, of good designs before constructions. Road contractors should be made to remove any quantity of soils, sand, chippings bitumen's collected in the drains after construction to give drains full capacity in order to be able to collect the required stormwater to be moved downstream.

Contractors should again work on the slopes of sand generated at the banks of the drains after construction. Too steeps slopes results in the washing of sand and soil into drains if not collected to give it a level height with the drains as shown in **Plate 3e.**

ISSN no. 2277-3037
Vol 10 No 11 (2021)

Plate 3e: Too steep banks of constructed drain

4 RECCOMMENDATIONS

- Need for the construction of closed drains to avoid people throwing refuse, debris and waste in drains
- Contractors should remove all soils, bitumen, chippings and any other materials collected in the drains after construction to give drains full capacity in collecting stormwater downstream
- The slope of banks of drains should be worked on and if possible levelled be same as drains to avoid be eroded into drains with plastics and other debris during storms as depicted in **plate 3d.**
- Ghana Highway Authority and Hydrological Service Department needs to have district offices like Ghana Education Service, Ministry of Food and Agriculture etc. for effective management of our roads and drainage systems. With this, there will be workers who will work on the roads and drains daily for its functionality, beauty and longevity.
- Road construction should be awarded to road contractors not to people who are politically affiliated and just interested in money.
- Need for road inspection after construction by experts to ensure standardization.

5 CONCUSION

The existence of cars and vehicular movements will continue to warrant the construction of rural and urban roads. Once such roads are to be constructed, it will call for the designing and construction of drains in order to collect all water on roads to avoid flooding and splashing during rains. Urbanization and creation of impervious surfaces during the building of 1st class houses and malls within the cities and urban areas such as Kade will also result in the construction of drains. This is what resulted in the creation of all drains indicated in the plates above with the motive of collecting stormwater and channeling it downstream into rivers, streams and lakes.

ISSN no. 2277-3037
Vol 10 No 11 (2021)

But due to lack of monitoring and maintenance, these drains are now in bad condition resulting in odors and been seen as a nuisance in Kade as they have been filled with all kinds of debris, refuse, plastics, soil and sewages as indicated in the plates. Ghanaian contractor's eagers and greediness is also a contributor to the bad engineering and drainage system in Ghana as under standardized roads and drains are constructed day in day out after winning contracts from government as a result of political affiliation. Findings from investigations indicating drain capacity for runoff collection is shown in the figure below;

Nature of some Drains	**% Drain capacity full with soil/water/weeds/Breakages**
With sewage water	20%
With Soil	100%
With soil and water	70%
Breakages	23%
With soil at the Banks	45%
Bad connection to culverts	3%
With settled stormwater	32%
With soil only	50%

Research investigations indicates that, drain construction is a major problem in Ghana as drains are under sized or oversized to take storm water. Or due to lack of monitoring and maintenances, Ghana Highway Authority and Hydrological Service Department lacks maintenance ability. Urbanization, civilization and creation of impervious services should result in the opening and widening of drains year in year out as more buildings and impervious surfaces continues to be created leading to more runoff generations over the catchment area. These stormwater ends up in the drain and if the drain is inadequate to collect the runoff, such stormwater will end up on the roads resulting flooding on roads and splashing which can lead to accidents.

Research findings got some road areas having stormwater running from drains unto the roads together with debris, refuse, plastics, weeds which have been accumulated in the drains during the dry season. Most of the drains which have collected sewage water produces odors and serves as breeding grounds for mosquitoes and frogs and other animals.

Its therefore of utmost importance that, road construction contracts be awarded to good drainage engineers and not just anyone else who is politically affiliated who will just contract people to do a shoddy work. Drains should be expected by experts to meet standards before paying contractors. Investigations revealed that no proper continuous repairs is done on drains and once they are constructed, that is all and this is shortfall.

Acknowledgements

I am very grateful to the Almighty God, for his protection and guidance in all my dealings and doings. It's by his grace that such a great height has been achieved. God bless you my wife,

ISSN no. 2277-3037
Vol 10 No 11 (2021)

Mrs. Rita Danquah for the help you rendered in getting this work done. Another appreciation goes to the Danquah family for their support and encouragement in all my doings. My final appreciation goes to the people of Kade. God bless us all.

References

- Department of Transport and Main Roads (DTMR), 2019, Road Surface and Subsurface Drainage Design, Pg.
- DRAINAGE SERVICES DEPARTMENT (DSD), January 2018, Stormwater Drainage Manual, Fifth Edition, Government of the Hong Kong Special Administrative Region.