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# ROUTE DESIGN: A GUIDE FOR ENGINEERING BILL OF QUANTITY

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## ABSTRACT

Road is an assets of nations economy and the driving force of integration and development. Road network plays a vital role in the social economic and political development of any country. Nigeria is aggregation state where most of its produced is concentrated in the rural area that are mostly in accessible due to inadequate road network, it became imperative to explore the means of providing sufficient road network to link rural areas with it adjourning city centers, in view of the important role played by adequate road networks in the economy of this nation as well as availability of survey data in the

## Introduction

### Background of the Study

The role of a surveyor in all level of construction especially road construction cannot be undermined because its function is measured from the point of commencement of the work to the point of termination (Oguche Sunday 2009). Route surveying which fall under engineering surveying embraces all engineering works, before any work commences large scale topographical map of the plan is required as a basis for design. The position of any new construction must then be marked out on the ground. Route surveying in a summary involves traversing and levelling. Traversing is for horizontal control alignment of the route while levelling is used to determine the elevation of points along the route (vertical control alignment). It's also involves longitudinal, cross sectioning and geometric design of the road. The major problem that prompted this research work are; lack of design plan for the construction of most of the engineering project before resuming to the site. Inappropriate planning and design of engineering bill of quantity by the contractor instead of the client. The project is located in Alkaleri Local Government Area of Bauchi State, geographically located on Longitude 09057'33.98"E, latitude 10010'55.91"N, and Longitude 09059'33.47"E, latitude 10009'57.32"N. The proposed road starts from Yelwan Duguri to Birim village with a length of Km 0+000 to Km 3+700m.

### Aim and Objectives

The aim of this research was to assess the increase in price of engineering project against the engineering bill of quantity (BEME). This was achieved through the following objectives:

i. To produce data for the design of engineering project
ii. To produce longitudinal and cross section for cost estimation

construction of such road networks. It provide data for the heighting, alignment, as well as for the setting out curves, culverts, bridges where necessary along communication routes such as road networks, railroads, canals, transmission lines, and pipelines. The proposed route starts from Yelwan Duguri to Birim village in Alkaleri Local Government Area of Bauchi State, covering a distance of habitants of both villages are mainly farmers and are in daring need of good roads, specifically this particular project if utilized, could facilitate the conveyance of their farm produces to the city centre. Sokkia SET 600 Total Station instruments was used to carry out the route survey along the proposed road to provide data on the existing Position and heights as well as the topographic features within the corridor for the plotting of the longitudinal profile of the road and subsequent Engineering design of the Geometry of the road. Levelling was carried out along the proposed route at 20m interval to provide vertical controls for the alignment of the centre-line of the route and for the design of the longitudinal profile. Hydraulic structure such as culvert and concrete line drain were designed in this research for road construction. Engineering bill of quantity was also produced for appropriate costing of engineering work. This research work is recommended for used by the Bauchi state Government as well as the Federal Government of Nigeria.

**Keywords:** Profile, Cross section, Engineering bill, Quantity, Costing and Road network,

iii. To design hydraulic structures for estimation of bill of quantity
iv. To generate the summary of bill of quantity for engineering project

**Project Planning**

Before commencement of this project, all necessary data and logistics were prepared. Three GPS controls established by Federal Surveys were traced for connection purpose. The coordinates of such controls were gotten from ministry of works, Bauchi state. Data such as the topographic-sheet or base map of the study area was also used for depicting the nature of the terrain. Required instruments for the actualization of expected accuracy, survey team, time stream and logistics were properly considered being a prerequisite to the success of any survey task. The preliminary inspection of the entire area was carried out. It involved going to the field to identify the existing controls used for connection as well as to enable me know the extent of the area to be surveyed and noting all areas that is likely going to cause difficulties thereby avoiding them. During this operation three sets of township controls were traced within the study area these are CNSB781, CNSB776 and CNSB789. The traversed points were carefully selected and permanently marked noting very well the inter visibility of these selected points as well as avoiding areas that such points cannot be easily removed. The main instruments employed for the execution of this project include a Sokkia SET600 Total station and its accessories such as reflector, tripod,

**Data Acquisition**

Instrument used were tested and were confirmed functioning optimally prior to field observations. To ascertain the functionality of the instrument used, observations were made

on the existing control while angle and distance measurements was carried out on same set of control coordinates computed and compared. This multifaceted testing proves both the instrument and the control in-situ. Total station was used centre line, left, and right wing of the route.

**GPS Control establishment**

GNSS observation was carried out on the buried pillars at regular interval of 1km along the proposed road. This served as the control points to provide checks for the total station observations. In the other hand it serves as a guide to determine the horizontal alignment of the route as well as to provide controls in case of setting out. For corridor mapping total stations observations was carried out between the established controls to provide x,y,z data necessary for the determination of longitudinal as well as the cross section of the proposed road at 25meter chainages.

**Data Processing and Analysis**

GNSS data was later downloaded to a computer using Spectrum survey Software then processed and adjusted. The adjusted data was converted to UTM projected coordinated and exported in Microsoft excel format. Total station observed data for corridor mapping, Longitudinal and cross section was downloaded to a computer via USB cable using Sokkia link software and also exported in to Microsoft excel file format for plotting in AutoCAD. The data acquire was used for the production of longitudinal profile and cross section. The contractor of all the sample used in the research is Messrs Triacta Nigeria Limited. It shows summary of previous BEME and increment in the price of engineering work. Hydraulic structures was produced using the observed data. Figure 1 is the 2.45m by 2.00m double cell culvert and the barrel reinforcement is shown in Figure 2 whereas Figure 3 showed the apron and wing wall reinforcement. Figure 4 showed 1.25 by 1.0 single cell box culvert. . Figure 5 showed single cell ring culvert of 90mm diameter. Figure 6 and Figure 7 showed a section of 80mmx100mm and 120mmx100mm concrete line drain respectively.

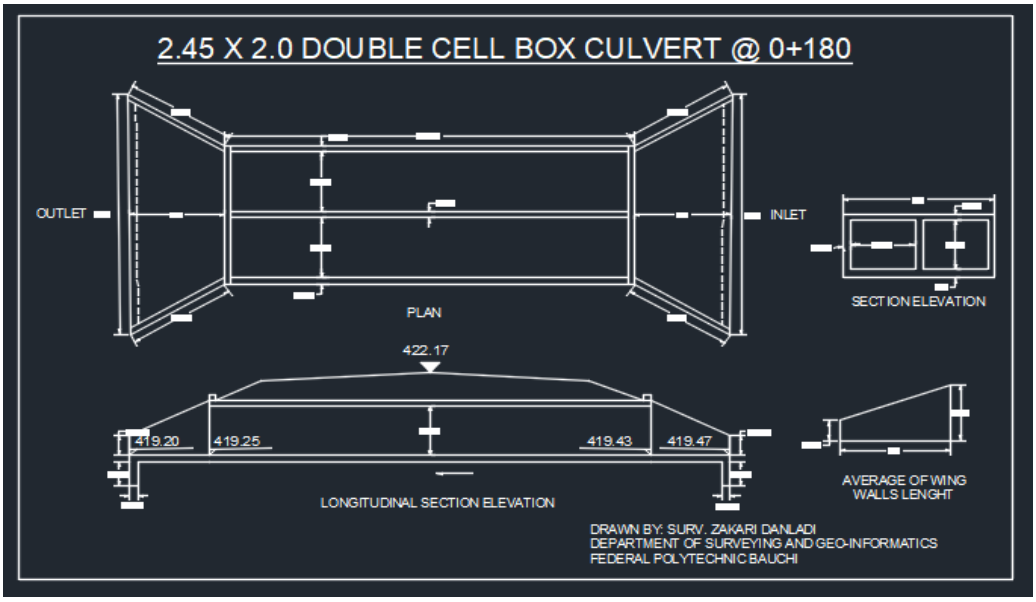


**Figure 1: Double Cell Box Culvert**

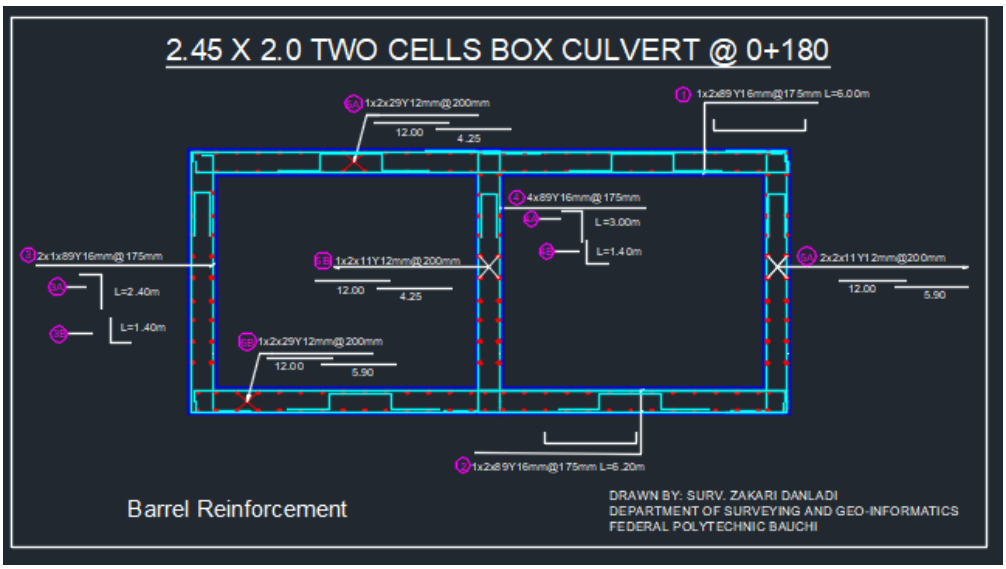


**Figure 2: Barrel reinforcement**

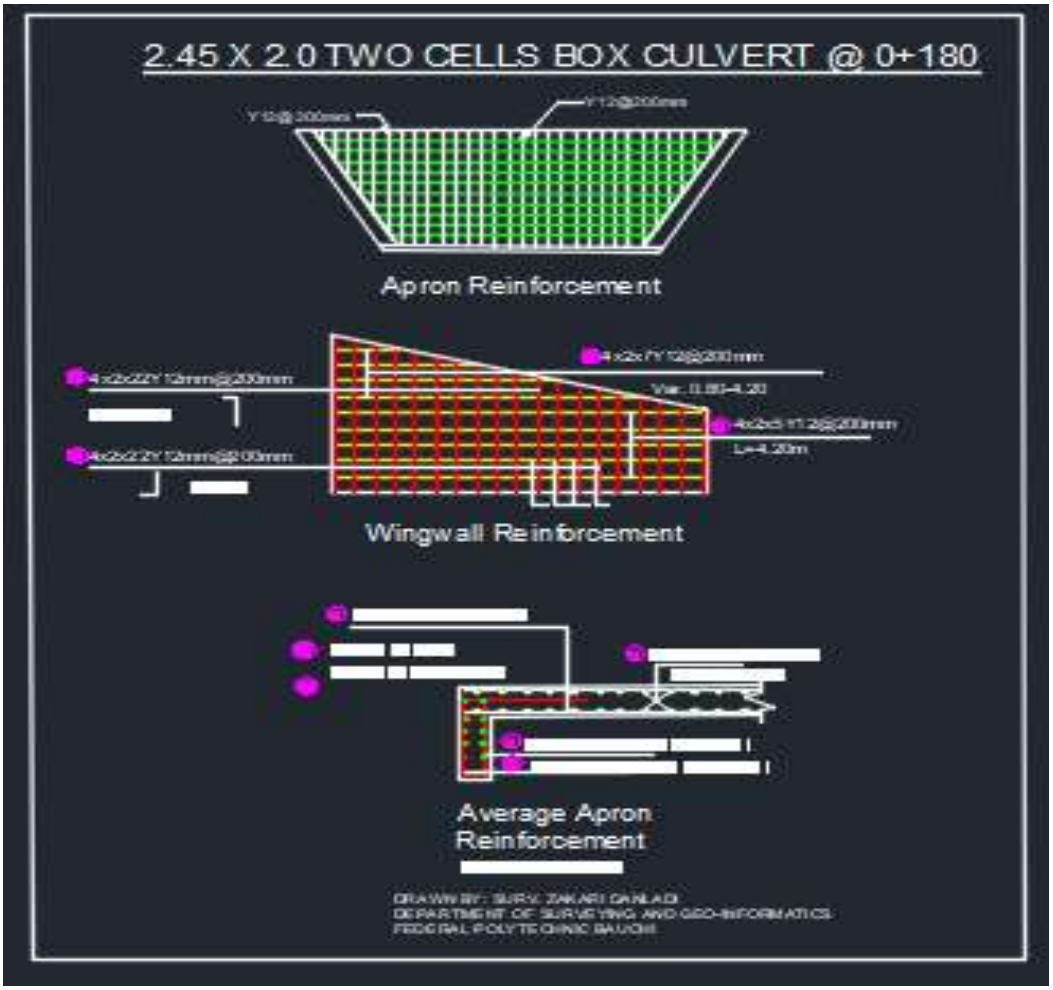


**Figure 3: Apron and wing wall reinforcement**



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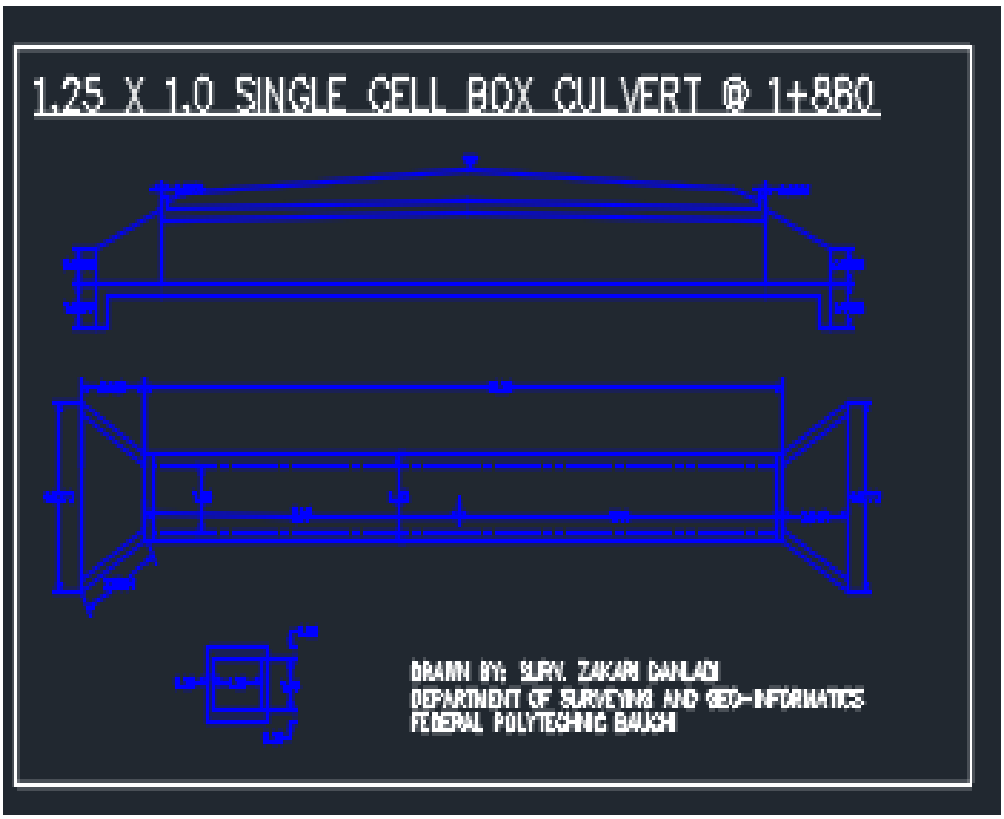


**Figure 4: Single Cell Box Culvert**

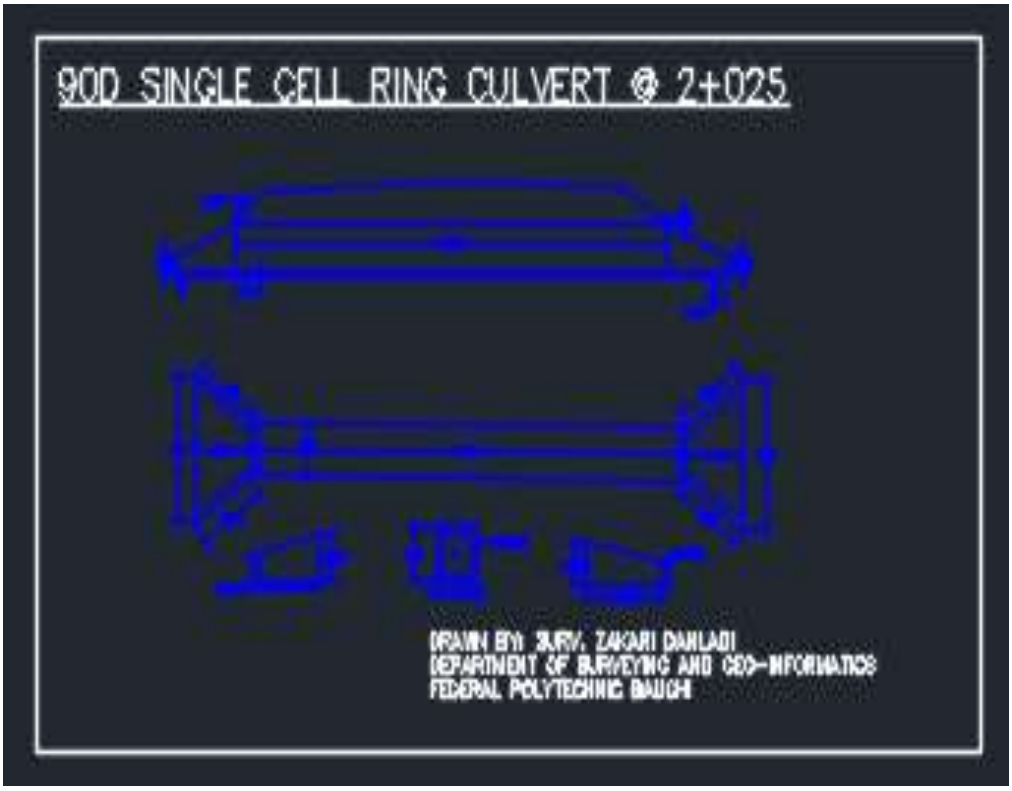


**Figure 5: Single Cell Ring Culvert**

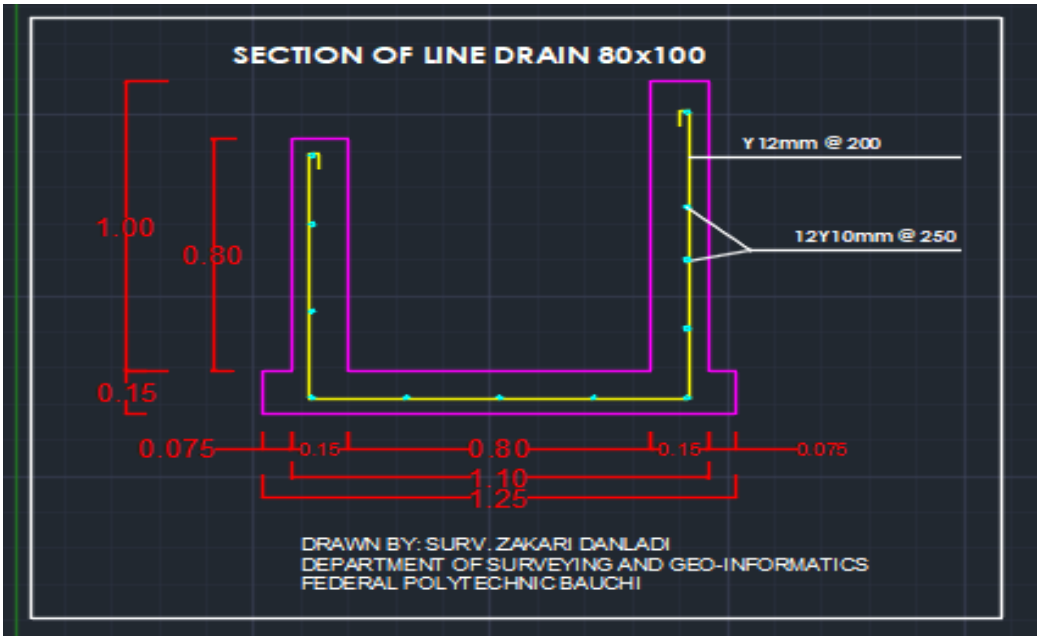


**Figure 6: Section of Concrete line drain (80x100)**

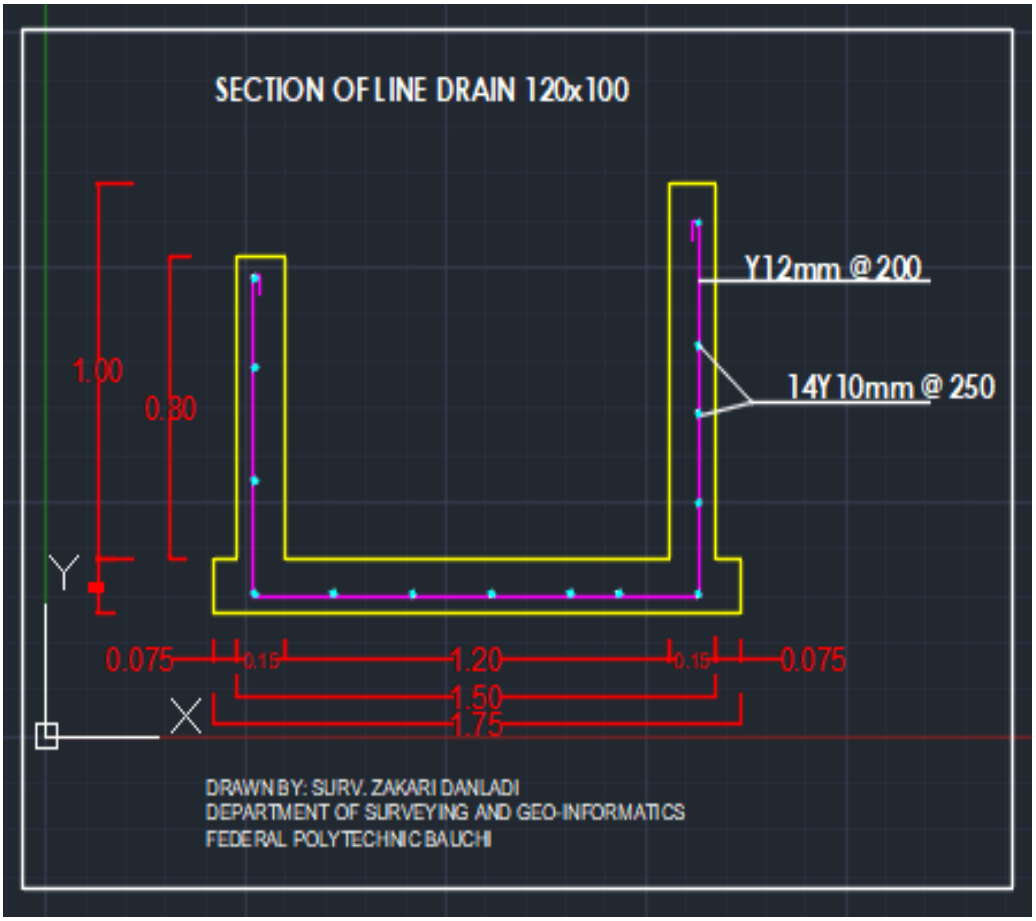


**Figure 7: Section of Concrete line drain (120x100)**

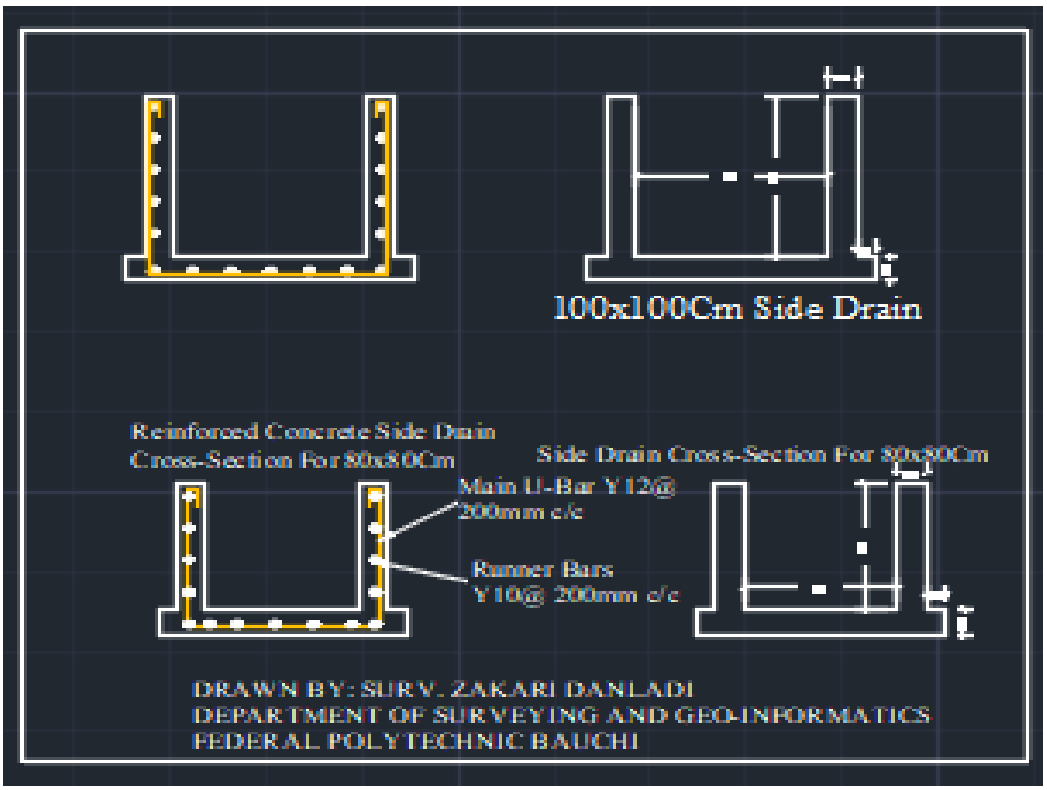


**Figure 8: Section of Concrete line drain (100x100)**

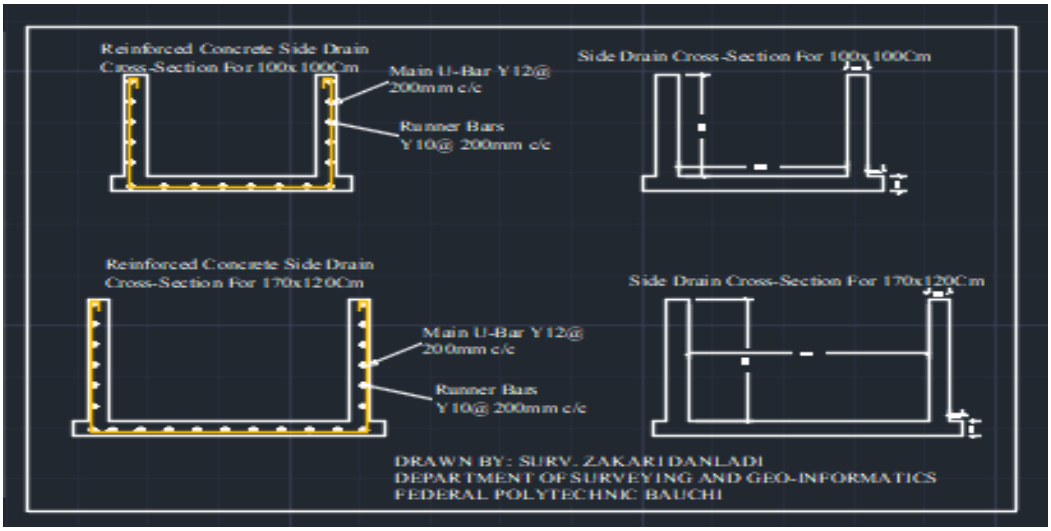


**Figure 9: Section of Concrete line drain (100x100)**

**Plotting of the Longitudinal Profile and Cross section**

Plotting of the longitudinal profile and cross sections was done in AutoCAD Civil 3D. The acquire data was imported as points using import/export command. After the display of points, it was used to model the terrain using terrain model program. The alignment of the road was then defined from the starting point of the road at chainages 0+000 to the end, including the curves along the route. The longitudinal profile generated from the surface as shown in Figure 10, Figure 11 and Figure 12. The cross section is shown in Figure 13 for computation of volume of earthwork.

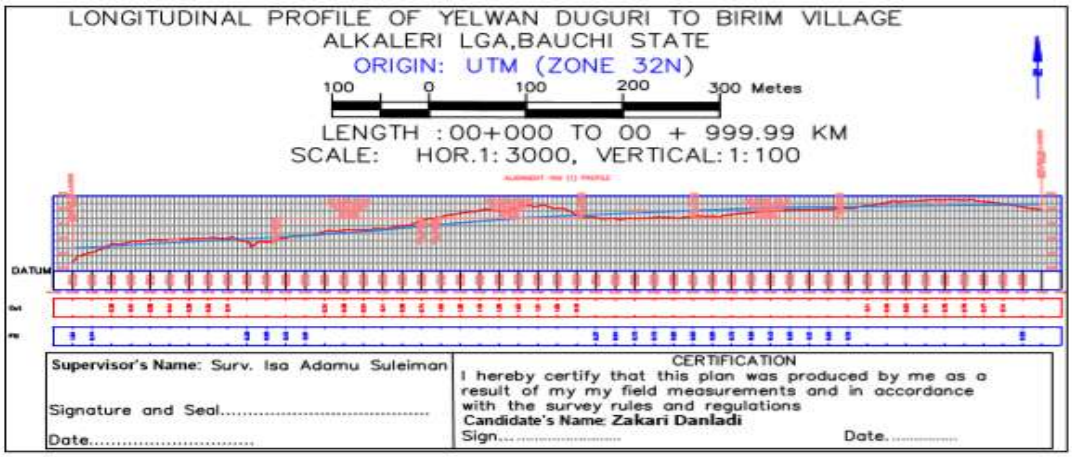


**Figure 10: Longitudinal Profile from 0+000 to 0+999.99 km**

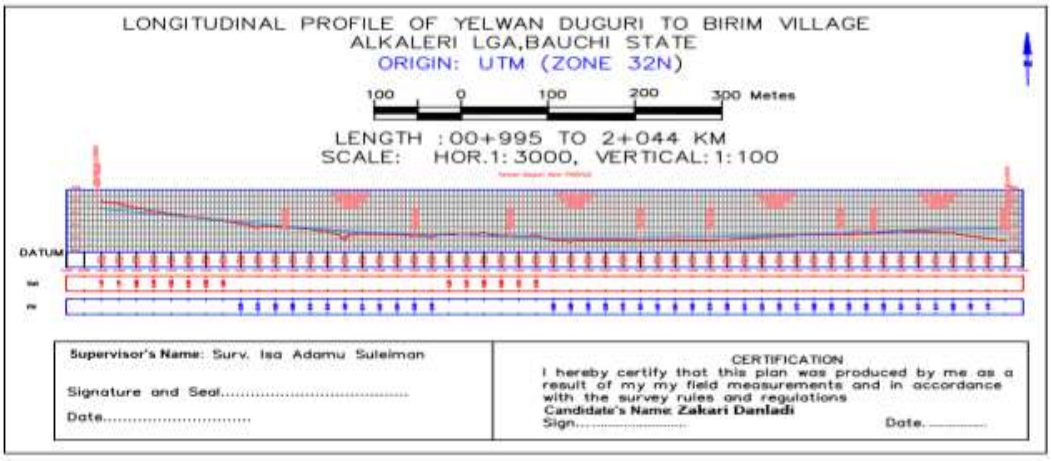


**Figure 11: Longitudinal Profile from 0+995 to 2+044 km**

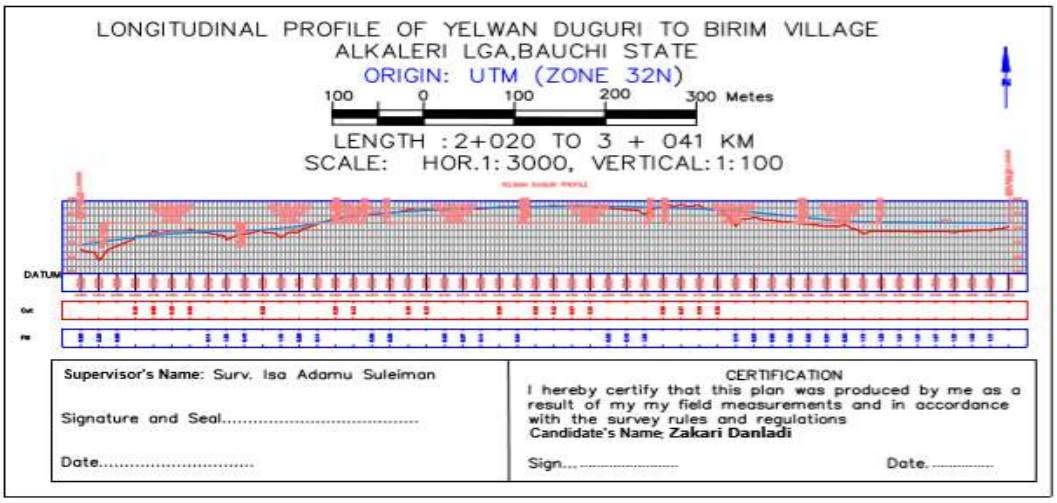


**Figure 12: Longitudinal Profile from 2+020 to 3+041 km**

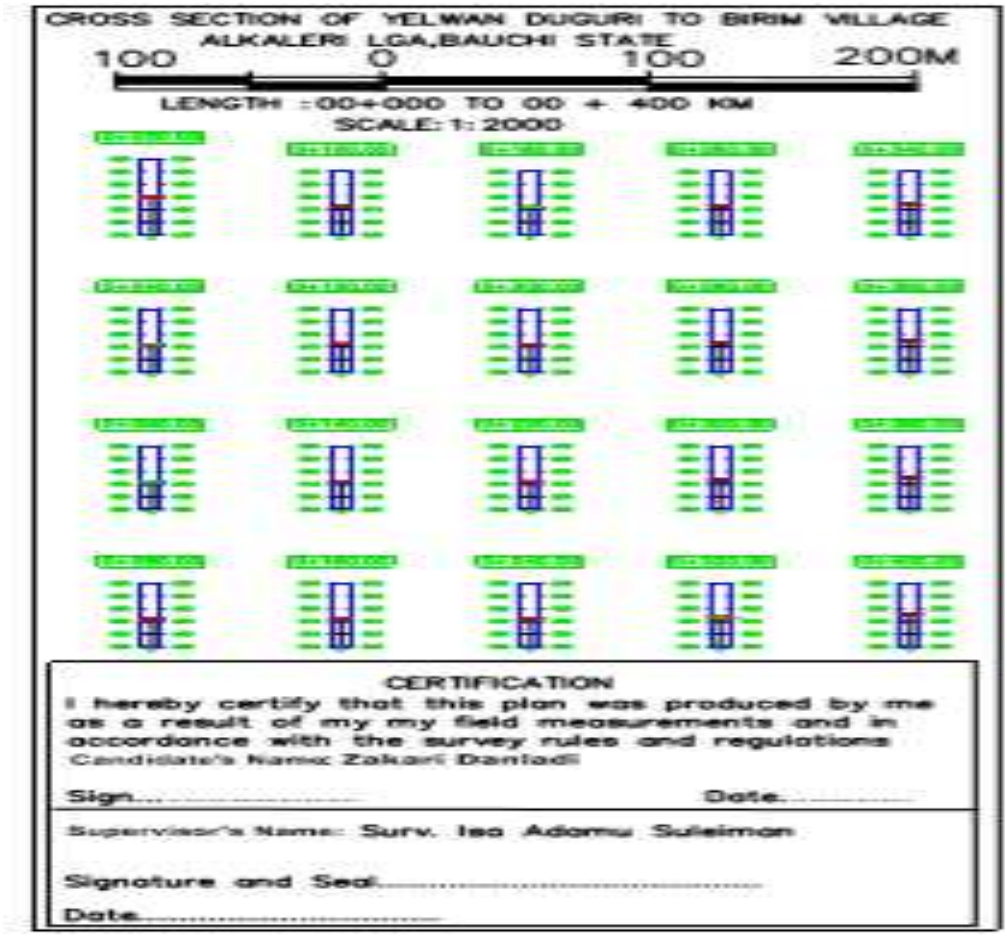


**Figure 13: cross section**

**Table 1: Summary of Computed Bill of Quantity (BOQ)**

| GENERAL SUMMARY OF B.E.M.E | | |
|---|---|---|
| **S/NO.** | DESCRIPTION | AMOUNT N:K |
| **1** | Project administration cost | 15,000,000.00 |
| **2** | Site clearance and earthwork | 137,532,000.00 |
| **3** | Culvert and drains | 362,900,000.00 |
| **4** | Pavement and surfacing | 198,280,000.00 |
| | **Sub Total (1)** | **713,712,000.00** |
| **5** | Add 5% Contingencies | 35,685,600.00 |
| **6** | Add 5% VOP | 35,685,600.00 |
| **7** | Add 0.25% Monitoring | 178,428.00 |
| | **Sub Total (11)** | **785,261,628.00** |
| **8** | Add 7.5% V.A.T | 58,894,622.100 |
| | **Grand Total** | **844,156,250.100** |

**Conclusion**

The longitudinal profile and cross section were produced, and the volume of the earthwork was also computed as presented in the report. The general bill of quantity was generated from

the designed culverts, concretes line drain, cross section and other component of the road. It is concluded that road deign, design of hydraulic structures and other component of road construction are necessary for production of engineering bill of quantity.

**Recommendations**

From the foregoing research, the following recommendations were drawn:

i. The Federal, State, local Government and other parastatals should adopt appropriate road design before given out contract to any construction film in order to minimize cost.
ii. Engineering project should be design properly before embarking on the work in order to mitigate the overshooting in contract sum at the end of the project.

**References**

Abo-Hashema M, etal (2006: Pavement maintenance management practices and GIS in Al-Ain: Third Gulf Conference on Roads (TGCR06)

Ajani Tomori (2001): Past, Present and Future Highway Management in Nigeria. A Journal of Civil Engineering on Road Maintenance and Management

Auto Desk AutoCAD Civil and AutoCAD Civil 3D (2009): A Rule-Based Road Design using Auto Civil and AutoCAD Civil 3D. A Training Manual of AutoCAD Civil 3D application software. www.autodesk.com/civil3d-countrykits.

Ayeni J.B (2003): GIS Cartography and Mapping for National Development. A Paper Presented at the Proceedings of Geoinformation for Development and Management of Nigeria's Resources Abuja, 26th-28th November

Ezenwa A.O et al (2008): Trends and Characteristics of Road Traffic Accidents in Nigeria.

Jenni Gray (2008): GIS Visualization for a Performance-based Road Maintenance rating Program Trend Analysis