

**THE ROUTE SURVEY AND DESIGN OF OKUO-OVO ROAD AT JESSE, DELTA
STATE**



BY

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UNIVERSITY OF BENIN, BENIN CITY

FACULTY OF ENVIRONMENTAL SCIENCE

DEPARTMENT OF GEOMATICS

SEPTEMBER, 2023.

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**A RESEARCH WORK SUBMITTED TO THE DEPARTMENT OF GEOMATICS,
FACULTY OF ENVIRONMENTAL SCIENCES, UNIVERSITY OF BENIN,
BENIN CITY, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE
AWARD OF BACHELOR OF SCIENCE DEGREE (B.SC) IN GEOMATICS.**

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CERTIFICATION

This is to certify that this project titled Route Survey and Design of Road at Jesse is an original work undertaken by Ogbeifun Shedrach Osemudiamen, supervised by Surv. (Dr) F.S Akinboro and has been prepared in accordance with the regulations governing the preparation of projects in the department of Geomatics, University of Benin. This project has been read and approved by:

SURV.(DR)F.S AKINBORO

.....

(Project Supervisor)

Date and Signature

SURV OLADOSU OLUSHOLA

.....

(Head of Department)

Date and Signature

DEDICATION

This project is dedicated to God Almighty, to my family and my friends for their love and support as well as my lecturers.

ACKNOWLEDGEMENT

My outmost gratitude goes to God for His grace in the successful completion of my academic program. I am also grateful to my Mom and Dad for their continuous love and support, without them I wouldn't have come this far. I am also thankful for the support and financial assistance that came from my siblings and relations during the course of this project.

To my project supervisor, SURV. (DR) F.S AKINBORO I appreciate your supervision, patience and the knowledge you freely shared.

Also, my sincere appreciation goes to the academic and non-academic Staff of the Department of Geomatics and the DEAN of The Faculty of Environmental Science, ENGR. PROF. RALPH EHIGIATOR, SURV. OLADUSO OLUSHOLA (HOD) for their relentless efforts to assist the students.

ABSTRACT

This project centers on the critical task of conducting a route survey and designing a particular road in Jesse Town, a community with growing infrastructure needs. The study blends traditional surveying methods with advanced technology, particularly Autodesk Civil 3D, to streamline the road design process.

The project's route survey commenced with meticulous data collection and benchmark establishment, ensuring data precision and the creation of accurate topographic maps. Traversing and leveling procedures provided a comprehensive understanding of the town's terrain. The data collected served as the basis for road design.

Autodesk Civil 3D played a pivotal role in the road design phase. The software facilitated the creation of horizontal and vertical alignments, cross-sections, and drainage systems, ensuring a cohesive and optimized road design. Furthermore, its 3D modeling capabilities provided realistic visualizations, enhancing stakeholder communication and decision-making. The project covers a view and detailed explanation of the route survey which in chider reconnaissance survey, theologize traversing and levelling operation as well as transferring of height across the road sections for proper road chambering and culvert design. The project result shows a well detailed road design which meets all the necessary criteria.

CHAPTER ONE

1.0 INTRODUCTION

1.1 THE BACKGROUND OF STUDY

The development of an efficient and well-designed road network plays a vital role in modern transportation systems. The route survey and design of a road are critical components in the planning and construction of road infrastructure (Yang et al, 1998). This project aims to undertake a comprehensive route survey and design process to create a safe, efficient, and environmentally conscious road.

The primary objective of the project is to gather accurate data, evaluate potential alignments, and design the road geometry while adhering to regulatory standards and environmental considerations. By following a systematic approach, the project will ensure that the road aligns with the needs of the community, enhances connectivity, and minimizes negative impacts on the surrounding environment.

The project encompasses several essential phases. The preliminary survey phase involves conducting reconnaissance surveys to gather initial data on the proposed road route, identifying existing physical features, and mapping the area (Zulkipli et al, 2001). This information serves as a foundation for subsequent stages.

In the route selection and feasibility analysis phase, various alignment options are evaluated based on technical feasibility, economic viability, and environmental impact. Geotechnical factors, soil conditions, and geological hazards are carefully assessed to determine the most suitable alignment. Additionally, social, economic, and environmental implications are thoroughly considered to ensure sustainable road development.

Once the alignment is selected, the geometric design phase begins. Detailed topographic surveys are conducted along the chosen route to accurately determine the road's horizontal and vertical alignment. Horizontal alignment involves the design of curves, tangents, and transition curves, while vertical alignment encompasses grades, cross slopes, and superelevation. Intersection design, access points, and drainage systems are also incorporated into the road design to optimize safety and functionality (Abdulhafedh, 2019).

Following the geometric design phase, the project moves on to developing detailed construction plans and specifications. Construction plans include comprehensive drawings, cross-sections, and profiles, providing precise guidance for the construction process. Specifications detail the required materials, construction techniques, and quality control measures. Moreover, accurate cost estimates and project schedules are prepared to facilitate effective project management.

Environmental considerations are of utmost importance throughout the project. An environmental impact assessment is conducted to identify potential environmental effects and propose mitigation measures. Compliance with local, state, and federal regulations regarding land use, water resources, and protected areas is ensured. Sustainable practices, such as erosion control, stormwater management, and habitat preservation, are incorporated into the road design to minimize environmental harm.

The successful completion of the route survey and design of a road project relies on the collaboration of a multidisciplinary team of professionals with expertise in civil engineering, surveying, geotechnical engineering, environmental science, and transportation planning. Stakeholders, including government agencies, local communities, environmental groups, and potential road users, play a crucial role in providing valuable input and ensuring the road meets the needs and expectations of all parties involved.

1.2 THE STATEMENT OF PROBLEM

Inefficient and unsafe road infrastructure hinders transportation systems, causing traffic congestion, accidents, and increased travel time. This project seeks to tackle the challenge of outdated or poorly designed road networks by conducting comprehensive route surveys and implementing optimized road designs, with a focus on improving traffic flow, safety, and overall infrastructure sustainability of the Okuo-Ovo Road.

The existing methods for conducting route surveys in challenging terrain lack a comprehensive framework that incorporates terrain features, accessibility constraints, and survey objectives to optimize the routing process. This leads to suboptimal route selections, increased time and resource consumption, and potential inaccuracies in data collection.

Therefore, the problem to be addressed in this research is:

How can we develop and evaluate optimal routing strategies for route surveys in challenging terrain that consider terrain characteristics, accessibility constraints, and survey objectives to improve efficiency and accuracy?

1.3 AIM AND OBJECTIVES

Aim: The aim of this project is to conduct a route survey and design of the Okuo-Ovo Road, ensuring the development of a safe, efficient, and environmentally conscious transportation infrastructure.

Objectives:

- I. Conduct a comprehensive route survey by acquiring coordinate data
- II. Carry out detailing of the route
- III. Analyze the data acquired and produce the road design.

1.4 SCOPE OF THE PROJECT: ROUTE SURVEY AND DESIGN OF ROAD

The scope of the project for route survey and design of a road encompasses a range of activities and deliverables necessary to develop a well-designed and functional road.

In summary, the scope of the project for route survey and design of a road encompasses a range of activities, including preliminary studies, route survey, alignment selection, geometric design, environmental impact assessment, stakeholder engagement, construction planning, cost estimation, project management, and compliance with regulations. The project aims to deliver a well-designed and functional road that meets the needs of the community while considering safety, environmental impact, and cost-effectiveness.

1.5 FACTORS INFLUENCING ROUTE SELECTION IN ROUTE SURVEY AND DESIGN OF OKUO-OVO ROAD:

The selection of a route for the Okuo-Ovo road project involves careful evaluation of various factors to ensure the road's alignment meets the project's objectives and requirements. The following are the key factors that favor the selection of a route:

- I. **Topography and Terrain:** The topography and terrain of the project area significantly influence route selection. The route should aim to minimize earthwork and cut and fill operations, as excessive excavation or embankment can lead to higher construction costs and potential environmental impacts. Selecting a route that follows the natural contours of the land can help reduce the need for extensive grading and earthwork.
- II. **Geotechnical Considerations:** Geotechnical factors such as soil conditions, stability, and potential geo-hazards must be assessed during route selection. A thorough geotechnical investigation helps identify areas prone to landslides, unstable slopes, or poor soil

conditions. Selecting a route with stable and suitable soil conditions reduces the risk of long-term maintenance issues and construction delays.

- III. **Environmental Impact:** Route selection should prioritize minimizing environmental impact and preserving sensitive ecological areas. Environmental considerations include the avoidance of protected areas, wetlands, wildlife habitats, and water bodies. A careful evaluation of potential environmental impacts, such as air and noise pollution, water pollution, and habitat fragmentation, should be conducted during the route selection process.
- IV. **Social and Cultural Factors:** The route selection process should take into account social and cultural factors to minimize the impact on local communities and cultural sites. The route should avoid or minimize disruption to residential areas, schools, hospitals, and places of cultural or historical significance. Engaging with local communities and stakeholders during the route selection process can help identify and address concerns and ensure a route that is acceptable and beneficial to the affected communities.
- V. **Accessibility and Connectivity:** The route should provide optimal accessibility and connectivity between key destinations. It should consider existing transportation infrastructure, including major roads, highways, and public transportation networks, to enhance connectivity and facilitate smooth traffic flow. Selecting a route that improves connectivity and accessibility to important economic centers, residential areas, and social amenities is crucial for the success of the road project.
- VI. **Cost and Economic Viability:** The economic viability of the route is a significant consideration. The route selection should aim to minimize construction costs, including land acquisition, earthwork, and utility relocation. A cost-benefit analysis should be

conducted to evaluate the economic benefits, such as reduced travel time, improved transportation efficiency, and potential economic development opportunities, against the construction and maintenance costs of the selected route.

- VII. Safety: Safety considerations play a vital role in route selection. The selected route should prioritize the safety of road users by minimizing hazards, providing appropriate sight distances, and avoiding or mitigating areas prone to accidents or congestion. Factors such as the presence of sharp curves, limited sight lines, or high accident rates should be carefully evaluated during the route selection process.
- VIII. Future Growth and Development: The route selection should consider future growth and development projections in the project area. Anticipating future changes in population, land use, and transportation needs is crucial to ensure the selected route can accommodate future traffic volumes and growth. The route should have sufficient capacity to handle projected traffic demand and allow for potential expansion or improvements in the future.
- IX. Legal and Regulatory Requirements: The selected route must comply with legal and regulatory requirements at the local, state, and federal levels. These requirements include land use zoning, environmental regulations, transportation standards, and safety codes. It is essential to consult with relevant regulatory agencies and obtain necessary permits and approvals during the route selection process.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 OVERVIEW OF THE ROUTE SURVEY AND ROAD DESIGN AT JESSE (OKUO-OVO ROAD)

The route survey and road design project at Okuo-Ovo village, Jesse aims to improve the transportation infrastructure within the village and surrounding areas. This overview provides a summary of the key aspects and objectives of the project.

Project Goals: The primary goals of the route survey and road design project at Jesse include:

- I. **Enhancing Connectivity:** The project aims to improve connectivity by designing an efficient road network that connects Jesse Town with important economic centers, neighboring towns, and key transportation corridors.
- II. **Improving Safety:** The project focuses on enhancing road safety by addressing existing hazards, improving sight distances, minimizing sharp curves, and implementing appropriate traffic control measures.
- IV. **Enhancing Traffic Flow:** The project aims to optimize traffic flow within Jesse Town by designing roads with appropriate lane widths, efficient intersections, and appropriate turning lanes.
- V. **Promoting Sustainability:** The project takes into consideration sustainable practices by minimizing environmental impact, incorporating pedestrian and cyclist-friendly infrastructure, and utilizing environmentally friendly materials and construction methods.
- VI. **Applying intense road construction techniques** such as the cement stabilization technique for a long-lasting road as some of the roads pass through swampy and erosion prone areas.

2.2 THEORETICAL FRAME WORK OF ROUTE SURVEY AT JESSE:

The theoretical framework for the route survey at Jesse Town provides a conceptual basis for understanding and conducting the survey process. It encompasses various theories, principles,

and methodologies that guide the collection and analysis of data to inform the road design. The following components form the theoretical framework for the route survey:

2.2.1 Geospatial Data Collection: The route survey utilizes geospatial data collection techniques to gather accurate and precise information about the project area. This includes the use of Global Positioning System (GPS) technology, remote sensing, and geographic information systems (GIS) to capture and analyze spatial data. The theoretical foundation for geospatial data collection lies in principles of surveying, cartography, and geodesy (Thakur, et al. 2017).

2.2.2 Steps in Geospatial Data Collection for the Route Survey of Okuo-Ovo Village:

Geospatial data collection is a crucial step in the route survey process for Okuo-Ovo Village. It involves gathering accurate and detailed information about the project area to inform the road design. The following steps outline the geospatial data collection process:

I. Define Project Objectives:

Clearly define the objectives of the route survey in Okuo-Ovo Village. Determine the specific data requirements for the road design, such as topographic features, existing infrastructure, land use patterns, and any other relevant spatial information.

II. Conduct Background Research:

Gather existing data and information about Okuo-Ovo Village and its surroundings. This may include maps, aerial imagery, satellite imagery, previous survey data, and any available geospatial datasets. Analyze this information to identify knowledge gaps and areas that require further data collection.

III. Plan the Data Collection Strategy:

Develop a comprehensive plan for data collection, considering the project objectives and the available resources. Determine the appropriate data collection methods and tools based on the desired accuracy, resolution, and scale of the data. Consider the feasibility of using GPS technology, remote sensing techniques, and ground-based surveys.

IV. Select Data Collection Techniques:

Identify the appropriate data collection techniques based on the project requirements. This may involve a combination of field surveys, GPS measurements, aerial or satellite imagery acquisition, and ground-based data collection methods. Determine the sampling strategy if necessary, considering factors such as the size of the study area and the desired level of detail.

V. Conduct Field Surveys:

Perform field surveys in Okuo-Ovo Village to gather on-site data. This may involve collecting information on topographic features, natural and man-made landmarks, vegetation, water bodies, and other relevant spatial characteristics. Use traditional surveying instruments or modern GPS equipment to capture accurate positional data.

VI. Process and Validate Data:

Process the collected data to ensure accuracy and reliability. This may involve georeferencing, orthorectification, and image processing techniques for remote sensing data. Perform quality checks, validate the data against ground truth measurements, and rectify any errors or discrepancies.

VII. Data Integration and Analysis:

Integrate the collected geospatial data with other relevant datasets, such as existing maps, infrastructure plans, and environmental data. Analyze the data to extract meaningful information and identify spatial relationships, patterns, and constraints that will influence the road design process.

VIII. Data Documentation:

Document the data collection process, including details about the methods, equipment used, and any limitations or challenges encountered. Create metadata and ensure proper data storage and organization for easy retrieval and future reference.

IX. Data Management and Sharing:

Implement appropriate data management practices to ensure the long-term usability and accessibility of the collected geospatial data. If applicable and appropriate, share the data with relevant stakeholders, such as government agencies, engineering firms, or research institutions, while adhering to data sharing policies and privacy considerations.

By following these steps, the geospatial data collection process for the route survey in Okuo-Ovo Village can effectively provide the necessary information for the road design, facilitating informed decision-making and a comprehensive understanding of the project area.

2.3 TOPOGRAPHIC SURVEY:

A topographic survey is a specialized land surveying technique that involves the precise measurement and mapping of the natural and man-made features of a specific area, typically at a

local or regional scale. This type of survey aims to create a detailed and accurate representation of the terrain's surface, including contours, elevations, vegetation, bodies of water, buildings, roads, and other relevant elements. The resulting topographic map or survey provides a comprehensive visual and numerical representation of the physical characteristics of the surveyed area, essential for various engineering, architectural, and land development purposes (Sharma, P. V. 1997).

The topographic survey plays a crucial role in the route survey of Okuo-Ovo village. Here are the steps involved in conducting a topographic survey for the route survey of Okuo-Ovo village:

2.3.1 Planning and Preparation:

1. Define the survey objectives and requirements, considering the specific needs of the route survey in Okuo-Ovo village.
2. Identify the boundaries and extent of the survey area.
3. Obtain necessary permissions and access to the survey site.
4. Determine the survey equipment and tools required, such as total stations, GPS receivers, leveling instruments, measuring tapes, and field notebooks.
5. Establish Control Points:
 - I. Set up control points in the survey area using precise surveying techniques. These control points serve as reference points for subsequent measurements.
 - II. Use GPS receivers or total stations to establish control points with known coordinates and elevations. These points should be spread out across the survey area for reliable referencing.
6. Field Survey:

- I. Conduct traversing: Establish a traverse network by measuring distances and angles between control points. This helps in linking the entire survey area and maintaining accuracy.
 - II. Use a total station or GPS receiver to measure distances, angles, and elevations at various locations within the survey area.
 - III. Collect data on natural features like land contours, water bodies, vegetation, and existing infrastructure (buildings, roads, etc.).
 - IV. Measure and record any man-made structures, such as buildings, bridges, utility lines, and other relevant features that may impact the road design.
7. Data Processing:
- I. Transfer the field data from the survey equipment to a computer or data processing software for further analysis.
 - II. Process the field data to calculate precise distances, angles, and elevations.
 - III. Use software tools like CAD (Computer-Aided Design) or GIS (Geographic Information System) to create a digital representation of the topographic features surveyed.
8. Topographic Map Creation:
- I. Utilize the processed data to create a topographic map of Okuo-Ovo village. This map should accurately represent the natural and man-made features within the survey area.
 - II. Include contour lines, spot elevations, water bodies, vegetation, existing infrastructure, and any other relevant details.
 - III. Label the map with key information, such as coordinates, scale, legends, and a title.
 - IV. Ensure the map is clear, readable, and properly scaled to facilitate further analysis and design considerations.

9. Documentation and Reporting:

- I. Prepare a comprehensive report documenting the topographic survey findings, methodologies used, and any significant observations or challenges encountered during the survey.
- II. Include the topographic map, survey data, and any relevant supporting documents.
- III. Present the report to the project team, stakeholders, and relevant authorities as necessary.

By following these steps, the topographic survey for the route survey of Okuo-Ovo village can provide accurate and reliable data on the existing features of the land. This data serves as a foundation for informed decision-making during the road design process.

2.4 ROAD DESIGN

2.4.1 Road design drawings

Road design drawings are essential for planning and constructing roads that are safe, efficient, and functional. These drawings provide detailed information about road alignment, dimensions, grades, and other important aspects of road design (Zhang et al, 2006). Here are some key techniques and considerations for creating road design drawings:

- I. **Understand Design Standards:** Before you start creating road design drawings, it's crucial to understand the local design standards, regulations, and guidelines. These standards vary from one region to another and may cover aspects like road width, lane width, shoulder width, pavement thickness, and more.
- II. **Base Map:** Begin by creating a detailed base map of the project area. This map should include existing features such as buildings, utilities, drainage structures, and topography. Accurate survey data is typically used for this purpose.

- III. Road Centerline: Draw the road centerline on the base map. This centerline represents the alignment of the road and serves as a reference for all other design elements.
- IV. Cross-Sections: Create cross-sectional drawings at regular intervals along the road alignment. These drawings show a side view of the road, including the road surface, shoulders, ditches, and any adjacent terrain.
- V. Grading Plan: Develop a grading plan that shows the proposed elevations and slopes for the road. This plan ensures proper drainage and controls the road's vertical alignment (grades and superelevation).
- VI. Alignment Plan: Create an alignment plan that illustrates the horizontal layout of the road. This plan includes curves, tangents, intersections, and any special features like roundabouts or traffic islands.
- VII. Lane and Shoulder Details: Specify the width and composition of each lane and shoulder. Typical details may include lane markings, edge lines, and rumble strips.
- VIII. Intersection Design: If the road includes intersections, design them with proper turning lanes, traffic signals, signage, and pavement markings. Intersection drawings should be clear and easy to understand.
- IX. Drainage Design: Incorporate drainage structures such as culverts, stormwater ponds, and swales into your drawings. Ensure that water is properly managed to prevent flooding and erosion.
- X. CAD Software: Utilize Computer-Aided Design (CAD) software for creating precise and professional road design drawings. CAD tools offer a wide range of features to streamline the design process.

- XI. Review and Approval: Submit your road design drawings for review and approval by relevant authorities, engineering teams, and stakeholders.

2.4.2 Road Design with AutoCAD ®Civil 3d®

2.4.3 The General Workflow

- I. Create base map—Road design typically begins by creating an existing conditions surface and compiling a base map of existing conditions; information about the topography, parcels, utilities, and other potential impacts to the route design.
- II. Design alignment—An alignment identifies the primary horizontal path, which is often the baseline for constructing a roadway. Alignments may be produced from already-existing CAD entities like lines, arcs, or polylines or from survey data gathered on the ground. They might be made using any of the numerous alignment layout tools available.
- III. Apply design standards—Establish the alignment restrictions and the design goal for the alignment. Parameters for superelevation and speed are included. At any point during the design process, design criteria may be assigned, regardless of when the alignment arrangement is being created. A complying alignment can be quickly designed with the use of warning notifications. Generate existing ground profile and design grades—Display existing ground surface data for the design alignment and create the finished grades. Finished grade profiles may be created graphically using profile creation tools, or generated from a best fit analysis of existing entities or from information from an external file.
- IV. Construct assemblies— By connecting individual subassembly objects, assemblies form the cross-sectional component of the design and aid in simulating the geometry

- and material composition of the road as well as defining how it interacts with nearby structures along the route. The Civil 3D Tool Palette contains prebuilt libraries from which the subassemblies are chosen. The Subassembly Composer can also be used to generate unique subassemblies.
- V. Build the corridor— A dynamic 3D model depiction of a corridor is created by combining horizontal, vertical, and cross-sectional design features.
 - VI. Analyze resulting model— Corridors can be used to generate surfaces, compute earthworks and quantity takeoffs, perform sight and visual analysis, and extract data for building purposes.
 - VII. Optimize design— One or more of the corridor components may need to be adjusted in order to obtain a better design. For instance, you can change the design profile to better balance the volumes of the cut and fill. Numerous techniques, including grips, tabular inputs, and object-specific editing commands, can be used to make edits. Additionally, because the road design is dynamic, adjustments to one part have an impact on the overall roadway model.

2.4.4 About Rule-Based Design

You can assess the design of road elements using AutoCAD Civil 3D in comparison to accepted industry standards or custom standards. The software delivers graphic alerts and/or notification suggestions while designers work to lay out designs to help warn you when standards are not followed. As a result of fewer review comments, less rework is required, there is greater consistency, and, most importantly, solid engineering design is made possible. Design check sets

and design criteria allow for this. The horizontal geometry of the centerline may be given design constraints, for example, assisting in meeting the minimal radius criteria for horizontal alignments based on design speed. Profiles can also be given design criteria. Considering the minimum K values based on the necessary stopping, passing, and headlight sight distance derived from design speed.

Design checks are another way to control road design as the geometry is being laid out. For example, design checks can be established that limit the minimum length of alignment tangents.



Fig 2.1: Design criteria and design check sets are options of Alignment and Profile Properties

2.4.5 Rule Violation Warnings

Warnings show up in various places to notify the designer when the relevant criteria or design checks are broken. Alert icons are shown where violations happen along the alignment or profile. The symbol's tool tip, which appears when you hover over it, gives a brief explanation of the violation. The warning symbol's appearance is determined by the alignment type. Warning

symbols will also be presented in the entity grid view to aid the designer in being aware of any issues. If a design contains flaws, the author may elect to correct them if the circumstances allow. When the issues are resolved, the warning symbols will disappear. A design criteria report can be generated, helping to identify whether each sub entity within a given station range violates or meets the appropriate design criteria and design checks. The reporting utility is accessed in the Toolbox tab of the Tool space.

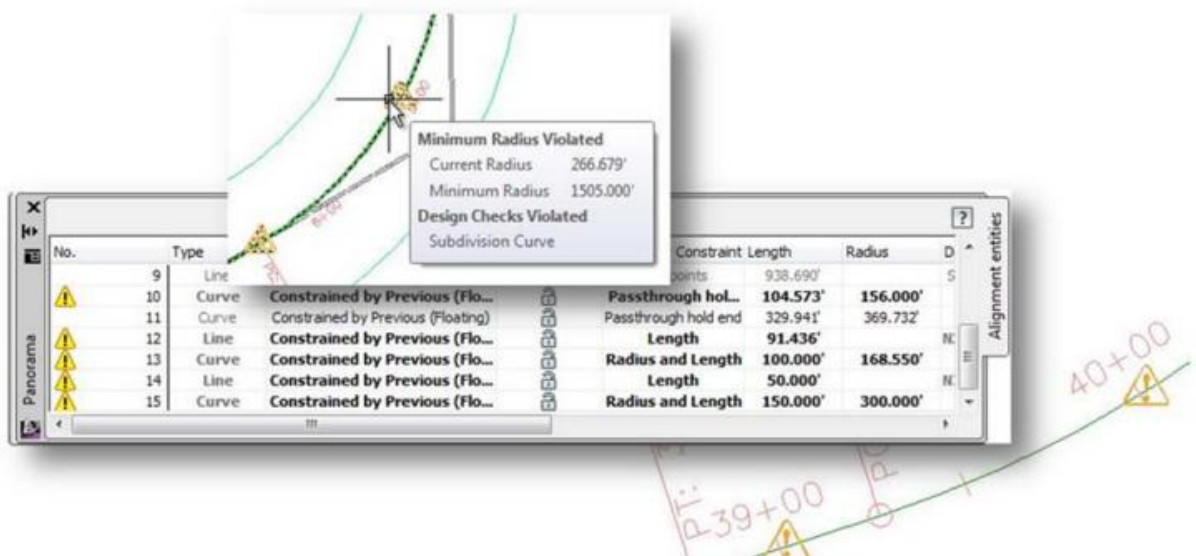


FIG 2.2: Violations of design criteria and design checks appear in several places to warn users.

2.4.6 Design Criteria Files

AASHTO-based design criteria files are included with AutoCAD Civil 3D software. These files can be used as-is, or copied and modified to better suit specific design needs. The application of design criteria is an optional property of the alignment and profile objects, as shown in Figure 2.3. The Design Criteria Editor is used to create custom criteria files. The default folder location

for design criteria files is: ...\\ProgramData\\Autodesk\\C3D 2013\\enu\\Data\\Corridor Design Standards\\

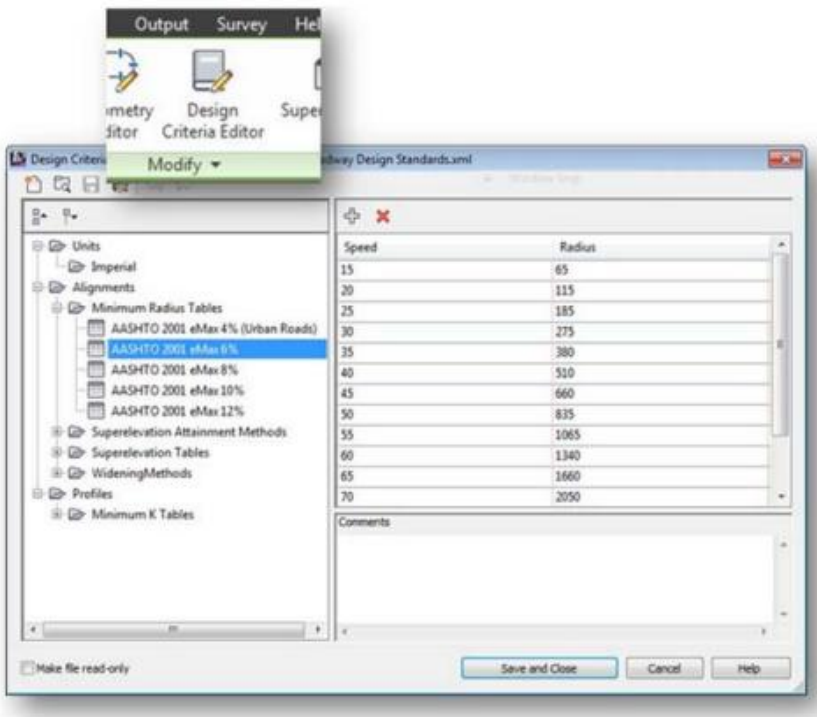


FIG 2.3: Editing design criteria in the Design Criteria Editor

2.4.7 About Design Checks

Design checks, which can be used independently or in conjunction with design criteria files, are an additional method for tracking and controlling the road design in real time. Design checks match a geometric characteristic of an alignment or profile with a preset value using mathematical formulae. For instance, tangent road segments may need to be longer than a predetermined length or curve radii may need to be greater than a minimum radius, depending on

the roadway design. Design checks can be organized into design check sets and handled through the Toolpace's Settings page.

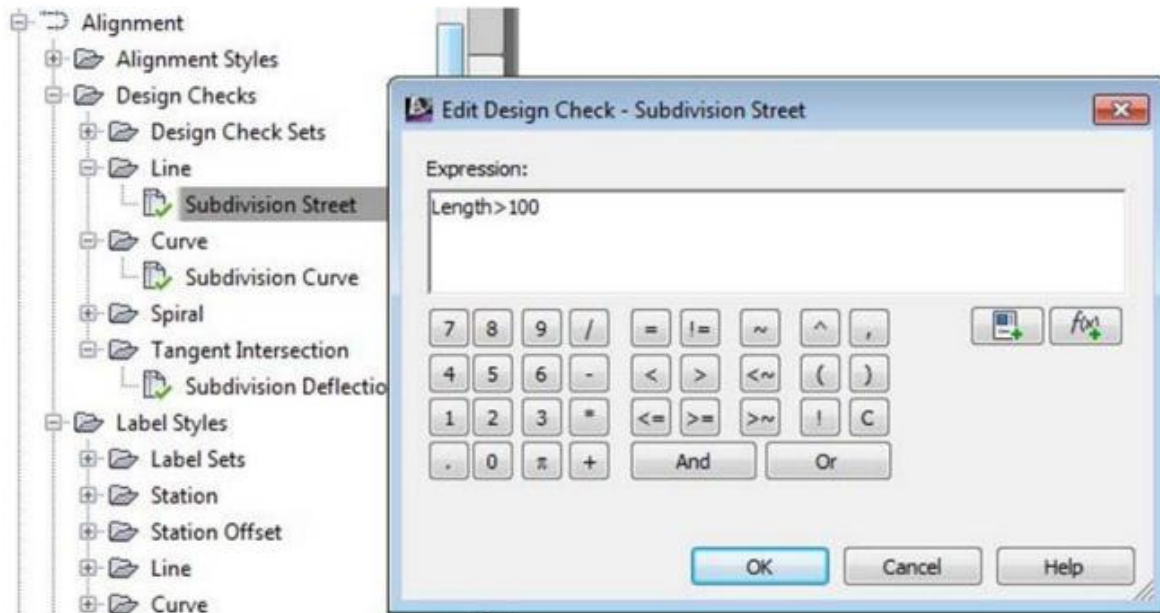


FIG 2.4: Design check rules are easy to modify and create. They are accessed in the Alignment or Profile collection of the Settings tab in the Toolpace.

2.4.8 Alignments

Roads, bridges, utility ditches, channel ways, and other features all have horizontal courses that are defined by alignments. Straight line tangents, as well as different kinds of curves and spirals, are used to represent their geometry. Rule-based design constraints may be used when connecting discrete geometry to generate an alignment.

2.4.8.1 Alignment Creation and Editing

Alignments may be created in a variety of ways. They may be created from existing line, arc, and polyline entities, or they may be created using the Alignment Layout tools, as shown in Fig 2.5. Alignments are edited using grip edits or alignment editing commands. Editing may also be done in tables using the alignment grid view, as shown in Fig 2.6.

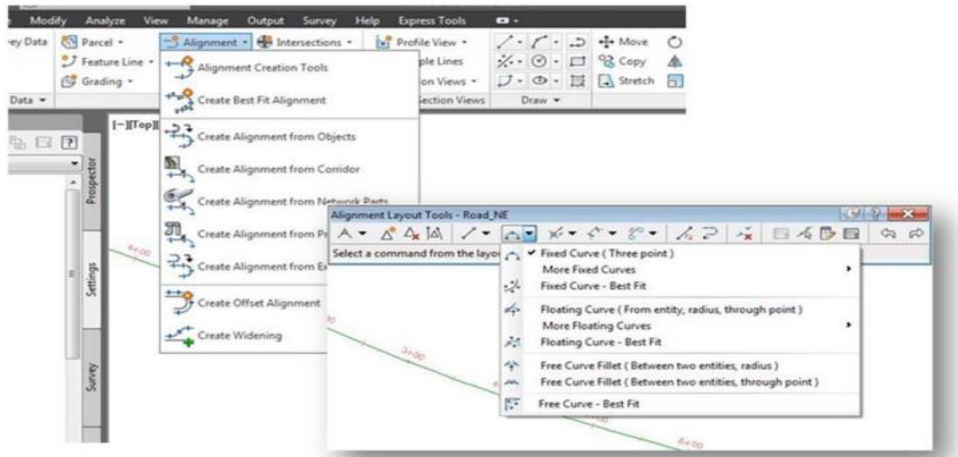


Fig 2.5: The Alignment Creation menu and the Alignment Layout toolbar

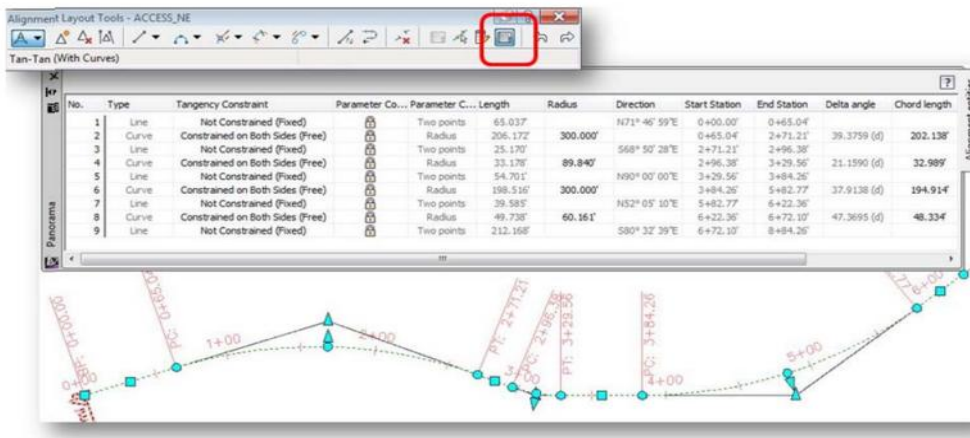


Fig 2.6: Alignments may be edited using graphical methods or by changing values in the Alignment entity panorama.

2.4.9 Superelevation

Superelevation is the banking of a curve to help counterbalance the centrifugal forces that a vehicle experiences while traveling through a curve. When superelevation parameters are applied to the alignment object, the resulting corridor model will rotate and warp the cross-sectional links and shapes to reflect the raising of one edge of the travel way above the other. The corridor relies on the behavior of subassemblies to adjust their final shape and position accordingly. Many out-of-the-box Civil 3D subassemblies support superelevation.

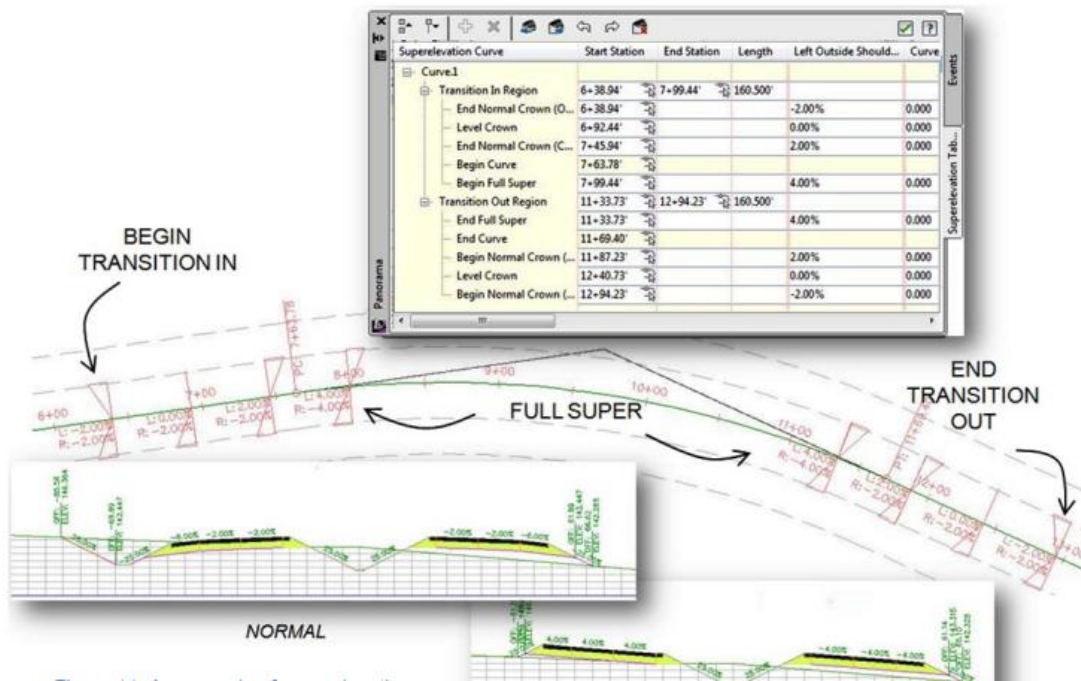


Fig 2.7: An example of superelevation being applied to a divided highway model.

2.4.9.1 Superelevation Attainment Methods

AutoCAD Civil 3D supports two methods of superelevation attainment:

- I. Standard: used on undivided, crowned roadways and divided roadways with crowned or planar sections.
- II. Planar: used on undivided, planar-section roadways, such as ramps and service roads.

The attainment method uses a series of formulas to calculate the length of the transition regions that transform the road from normal crown to full superelevation. Using formulas to establish relationships between maximum superelevation rates, runoff and runout lengths, and other variables, each specific transition region can be calculated. These values are obtained from the assigned design criteria file.

2.4.9.2 The Superelevation Wizard

The Superelevation wizard helps you define superelevation using a four-step process with visual cues at each step in the process. As options are selected, the associated configuration image will react to display the method scheme, as shown in Fig 2.8.

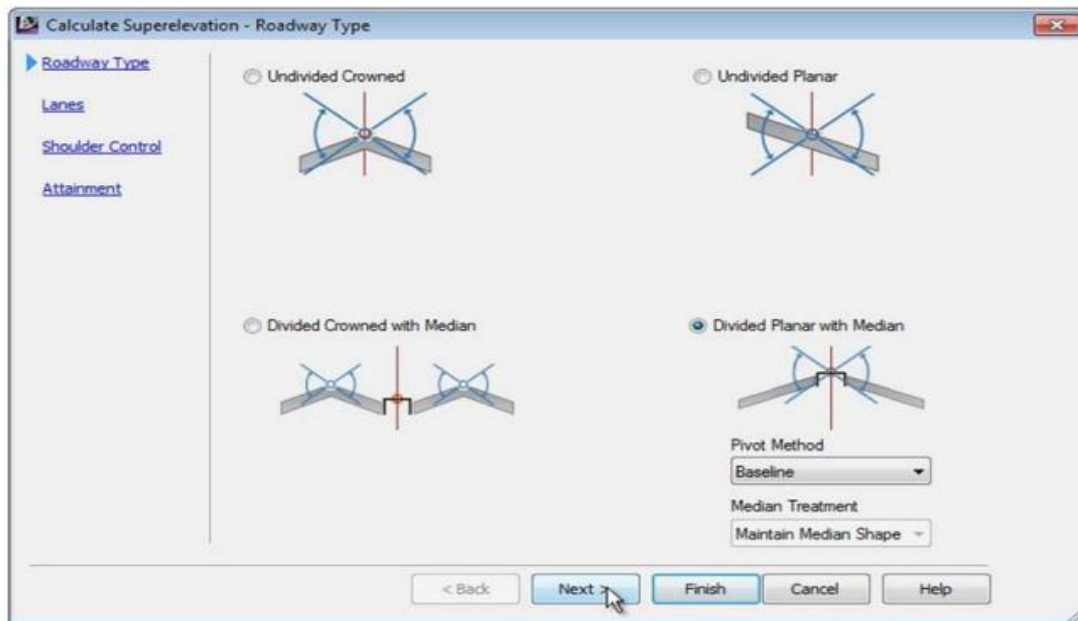


Fig 2.8: The first task in the Superelevation wizard is to select the roadway type. The images change to reflect a schematic representing the methods and options selected.

The wizard specifies roadway type, number of lanes, shoulder control, and attainment method for calculating superelevation.

The Superelevation wizard is used to:

- I. Calculate the superelevation for all curves or a selected curve in an alignment
- II. Store the design criteria in the superelevation curve manager for review or editing after data is calculated

The designer should have a well-defined concept of the design and desired superelevation behavior before starting the wizard. However, if design intent changes it is easy to reapply the Superelevation wizard to existing data, and there is a warning prompt to verify that all existing values will be overwritten.

2.4.9.3 Editing and Displaying Superelevation Data

Superelevation values for individual curves are displayed and edited using the Superelevation Curve Manager. It is accessed by selecting the alignment either in the drawing or from the Prospector tab. A grid view of all superelevation values for the entire alignment may also be used for review and editing. The grid view is launched by selecting the View Tabular Editor in the alignment context commands.

2.4.10 Profiles

Profiles define the surface elevation along an alignment. Design grade profiles are defined using tangents and vertical crest and sag curves. Profile geometry may be controlled using design criteria that specify three types of minimum K tables based on stopping sight distance, passing sight distance, and headlight sight distance (K-value represents the horizontal distance along

which a one percent change in grade occurs on the vertical curve). Additional criteria and design checks can include slopes and curves that are designed for safe or comfortable driving at a particular speed, or for sag curve drainage considerations.

2.4.10.1 Applying Design Criteria Files to Profiles

Design criteria is applied to profiles using methods similar to the ones used for alignments; criteria and design checks can be applied at the onset of design or afterwards. If the profile's parent alignment uses design criteria, that design criteria file is automatically applied to the profile by default.

2.4.11 Assemblies

Assemblies represent the cross-sectional composition of the road design. Assemblies are collections of individual subassembly components representing items such as medians, lanes, curbs, sidewalks, and shoulders. The assembly object serves as the baseline to which the designer snaps together any number of premade subassembly pieces from the Civil 3D Tool Palette.

Assemblies may contain functionality that is critical in the building of complex road systems, such as intersections, conditional daylighting, and superelevation

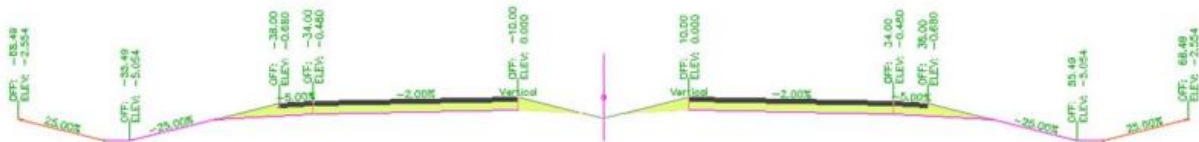


Fig 2.9: The assembly in this example uses two Lane Outside Super With Widening subassemblies, with one on each side.



Fig 2.10: Details of the right side of the assembly used in this example.

The solutions for road design in AutoCAD Civil 3D software make defining, annotating, and analyzing your road design more efficient and help your design comply with sound engineering standards.

Using criteria-based design, road modeling with real-time analysis and designer feedback helps expedite the design process and minimizes problematic issues.

Additionally, a good understanding of subassemblies and their functions enables the efficient construction of more accurate, construction-ready corridor models. Utilizing points, links, shapes, codes, target parameters, and road models, which can be tailored to your designs needs, will automate many repetitive and/or difficult road design tasks, such as labeling and updating cross section sheets (AUTOCAD® CIVIL 3D® white paper, 2013).

2.5 Review of Related Literature: Route Survey and Design of Road

- I. Study by Fred L. Mannering, Scott S. Washburn, and Walter P. Kilareski, 2012
"Geometric Design of Highways and Streets"

The principles and methods of geometric design for roads and streets are thoroughly covered in this book. It addresses issues like intersection design, cross-section design, alignment design, and

traffic control techniques. The book provides insightful information on the geometric design factors that should be taken into account while planning routes and designing roads.

- II. Study by Lester A. Hoel, Nicholas J. Garber, and Adel W. Sadek "Transportation Infrastructure Engineering: A Multimodal Integration" 2019.

The design of roads, highways, and other transportation facilities is covered in detail in this textbook, which offers a wide view on transportation infrastructure engineering. Route planning, surveying methods, geometric design, pavement design, and traffic management are some of the subjects it covers. The book provides a thorough overview of the numerous factors involved in route survey and road design.

- III. Study by Daniel J. Findley, Bastian J. Schroeder, Christopher M. Cunningham, and Richard L. Dobson "Highway Engineering: Planning, Design, and Operations" 2015.

The planning, creation, and maintenance of highways are the main topics of this textbook. Route selection, surveying, geometric design, traffic flow analysis, and safety considerations are some of the subjects it covers. The book offers thorough justifications and illustrations, making it a valuable tool for comprehending both the theoretical and practical facets of route survey and road design.

- IV. Study by Richard Robinson, Bent Thagesen, and Michael R. Troelsen "Road Engineering for Development" 2004.

This book looks at road engineering from the standpoint of development, highlighting the significance of taking into account economic, social, and environmental concerns. It includes subjects like road design, surveying methods, geometric layout, drainage, and road up

keep.

The book provides insights into the difficulties and factors unique to road development projects, making it pertinent to route survey and road design in a variety of contexts.

- V. Study by Roger L. Brockenbrough and Kenneth J. Boedecker "Highway Engineering Handbook" 2009.

Surveying, geometric design, pavement design, traffic engineering, and construction methods are just a few of the topics covered in this extensive reference book on highway engineering. For use in the process of route survey and road design, it offers comprehensive information, recommendations, and design criteria. For engineers working on road design projects, the book is a useful reference.

These literature sources offer valuable insights into the principles, methodologies, and best practices related to route survey and road design. They provide a foundation of knowledge and guidance for professionals involved in the planning and design of road infrastructure.

2.5 SUMMARY OF LITERATURE REVIEW

The literature review on route survey and design of roads encompasses several valuable sources that provide insights into the principles and practices related to this field. The reviewed literature includes textbooks and reference books that cover various aspects of geometric design, planning, surveying, and engineering of highways and roads.

- I. The first source, "Geometric Design of Highways and Streets," offers a comprehensive overview of geometric design principles for highways and streets. It addresses alignment design, cross-section design, intersection design, and traffic control measures, making it relevant to the route survey and road design process.

- II. The second source, "Transportation Infrastructure Engineering: A Multimodal Integration," provides a broader perspective on transportation infrastructure engineering. It covers route planning, surveying techniques, geometric design, pavement design, and traffic management, offering a comprehensive understanding of the different aspects involved in the route survey and design of roads.
- III. The third source, "Highway Engineering: Planning, Design, and Operations," focuses on the planning, design, and operations of highways. It covers topics such as route selection, surveying, geometric design, traffic flow analysis, and safety considerations, providing detailed explanations and examples to aid in understanding the theoretical and practical aspects of route survey and road design.
- IV. The fourth source, "Road Engineering for Development," emphasizes the importance of considering economic, social, and environmental factors in road engineering. It covers road planning, surveying techniques, geometric design, drainage, and road maintenance, addressing the unique challenges and considerations specific to road development projects.
- V. The fifth source, "Highway Engineering Handbook," serves as a comprehensive reference for highway engineering. It covers surveying, geometric design, pavement design, traffic engineering, and construction techniques, providing detailed information, guidelines, and design standards applicable to the route survey and road design process.

In summary, the literature review provides a wealth of information on route survey and road design. The sources offer insights into geometric design principles, surveying techniques, traffic analysis, environmental considerations, stakeholder engagement, and regulatory compliance.

These resources serve as valuable references for professionals involved in the planning, design, and implementation of road infrastructure projects.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 DESCRIPTION OF STUDY AREA

Early Origins

The story of Jesse's road begins with its humble origins. Dating back to the pre-colonial era, this road served as a vital artery for trade and cultural exchange among the indigenous communities of Delta State. Its significance only grew during the colonial period when it facilitated the movement of goods and people under British rule.

Post-Independence Development

Following Nigeria's independence, significant investments were made to upgrade and expand the road network. The road became a symbol of progress and connectivity, fostering economic growth and social cohesion within the region.

The Present State of Jesse's Road

As of the present day, Jesse's road stands as a mixed bag of challenges and potential. While some sections have been well-maintained, others suffer from neglect and wear. Potholes, uneven surfaces, and inadequate drainage systems are issues that commuters face regularly.

The road's importance in connecting various towns and villages has led to increased traffic over the years. This has resulted in congestion during peak hours and the need for traffic management solutions.

Community Life Along the Road

Jesse's road is not just a thoroughfare; it's a lifeline for the communities it serves. Along its course, you'll encounter bustling markets, schools, healthcare centers, and vibrant cultural landmarks that offer a glimpse into the local way of life.

The Future Prospects of Jesse's Road

The government of Delta State has recognized the significance of Jesse's road and has initiated plans for comprehensive improvements. These plans include road expansion, better maintenance, and infrastructure upgrades to meet modern standards.

Economic Impact

Investment in the road's development is expected to boost economic activities in the region. Improved transportation will facilitate the movement of goods and services, stimulating trade and job creation.

Environmental Considerations

In an era of increasing environmental consciousness, measures will be taken to ensure that road development is carried out in an eco-friendly manner, minimizing its impact on the surrounding environment.

In conclusion, Jesse, Okuo-Ovo road is more than just a physical connection between places; it's a thread that weaves together the past, present, and future of Delta State. With government initiatives and a commitment to sustainable development, the road's future looks promising. As travelers continue to explore its scenic beauty, it remains a testament to the resilience and progress of the region.

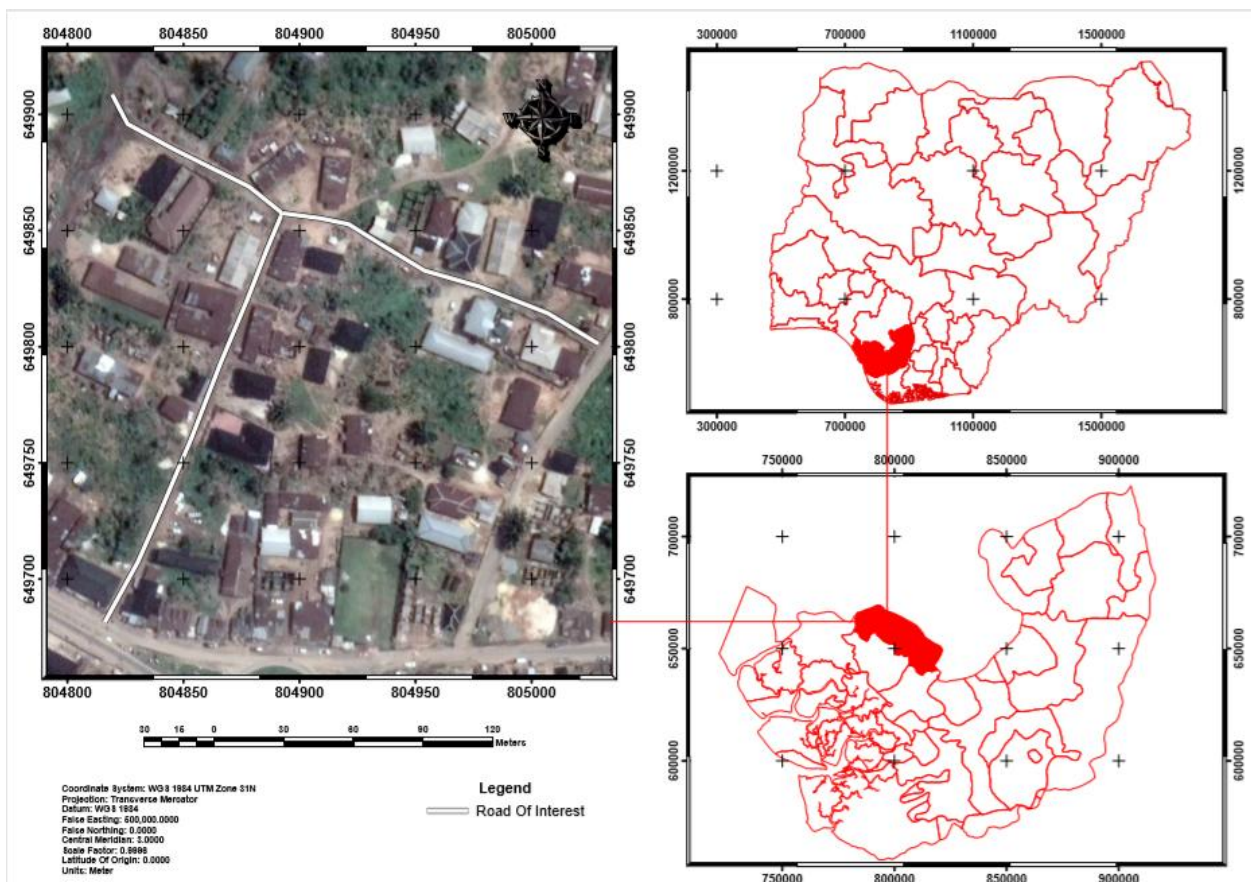


FIG 3.1 Satellite Imagery of Road Construction Site Map at Okuo-Ovo Community

3.2 RESEARCH DESIGN

The research design for the project on route survey and road design at Okuo-Ovo Village outlines the systematic approach and methodologies to be employed in conducting the necessary research activities. It provides a blueprint for collecting, analyzing, and interpreting data to inform the road design process. The following components are essential in the research design:

- I. **Research Objectives:** Clearly define the research objectives, which may include assessing the existing road infrastructure, understanding the transportation needs (Boisjoly, G et al 2017) of Okuo-Ovo Village, identifying potential road design improvements, and evaluating environmental impacts. These objectives guide the research process and help ensure that data collection and analysis align with the project's goals.
- II. **Data Collection Methods:** Determine the appropriate data collection methods to obtain relevant information. This may involve a combination of primary and secondary data sources (Wolfe, A. C. 1982). Primary data collection methods may include field surveys, interviews, questionnaires, and traffic counts. Secondary data sources may include existing maps, aerial imagery, demographic information, and previous studies or reports related to the area.
- III. **Sample Selection:** If applicable, determine the sample selection criteria for surveys or interviews. This may involve randomly selecting households or businesses within Okuo-Ovo Village or targeting specific groups such as commuters, local authorities, or community leaders. Ensure that the selected sample is representative of the population and provides a comprehensive understanding of the transportation needs and preferences (Wolfe, A. C. 1982).
- IV. **Data Analysis:** Define the methods for analyzing the collected data. This may involve quantitative techniques such as statistical analysis, traffic flow modeling, or GIS analysis.

Qualitative data, such as responses from interviews or open-ended survey questions, may be analyzed thematically or through content analysis. The analysis should be guided by the research objectives and aim to extract meaningful insights (Wolfe, A. C. 1982).

- V. Environmental Impact Assessment: If the project includes an environmental impact assessment, outline the methods for assessing and analyzing the potential environmental impacts of the road design (Toro, J et al). This may involve studying air quality, noise levels, water resources, wildlife habitats, or cultural heritage sites. Determine appropriate assessment methodologies and tools, such as environmental monitoring, modeling, or ecological surveys.
- VI. Reporting and Dissemination: Plan how the research findings will be documented, presented, and disseminated. This may include preparing research reports, presentations, or visualizations to communicate the results to project stakeholders, community members, and relevant authorities.

3.3 DATA COLLECTION TECHNIQUES

The route survey at Okuo-Ovo Village requires the collection of various types of data to inform the road design process. The ground survey is the major:

Ground Surveys:

Ground surveys involve collecting data directly on-site using various instruments and techniques.

Some of the key ground survey techniques for the route survey at Okuo-Ovo Village include:

- I. Total Station: A total station is a surveying instrument that combines electronic distance measurement (EDM) and electronic theodolite capabilities. It can measure distances, angles, and elevations accurately.
- II. GPS (Global Positioning System): GPS receivers can be used to collect precise location data using satellite signals. This technique is particularly useful for establishing control points and capturing the coordinates of various features within the survey area.
- III. Automatic Level: Leveling instruments are used to determine the relative elevations of different points along the route. This information is crucial for creating accurate contour maps and assessing slope gradients.
- IV. Measuring Tapes: Measuring tapes are commonly used for measuring distances on the ground, such as road widths, lengths of existing infrastructure, and setbacks from property boundaries.
- V. Wooden Pegs: Wooden pegs were used for marking out the traverse chainages in intervals of 50m and 25m respectively. It is properly aligned to give a clear and straight figure of the road.

3.4 DATA ANALYSIS TECHNIQUES

Data analysis techniques play a crucial role in the route survey project at Okuo-Ovo Village, as they help extract meaningful insights and inform the road design process. Here are some key data analysis techniques that can be employed:

- i. **Contour Analysis:** Contour analysis involves analyzing the collected topographic data to identify and understand the terrain characteristics of the survey area. This technique helps in visualizing the elevation changes, identifying slopes, and determining the overall landform. Contour maps are generated using interpolation techniques, and contour intervals are analyzed to identify areas of steep gradients, flat terrain, or potential drainage patterns.
- ii. **Cross-Section Analysis:** Cross-section analysis involves examining the elevation profiles along predetermined cross-section lines across the survey area. This technique helps in understanding the variations in ground levels, identifying areas of cut and fill, and assessing the suitability of the terrain for road construction. Cross-sections are analyzed to determine the road alignment, appropriate road grades, and potential areas that require earthwork or slope stabilization measures.
- iii. **Traffic Flow Analysis:** Traffic flow analysis focuses on evaluating the existing traffic patterns and volumes within Okuo-Ovo Village and its surrounding areas. This analysis involves studying traffic counts, peak-hour traffic distribution, travel speeds, and vehicle classifications. The collected data can be analyzed to identify traffic bottlenecks, peak traffic periods, and areas that require specific traffic control measures such as signalized intersections, roundabouts, or dedicated turn lanes.
- iv. **Safety Analysis:** Safety analysis involves assessing the existing road conditions and identifying potential safety hazards along the proposed route. This analysis utilizes data on historical accident records, road geometry, sight distances, and speed limits. Techniques such as crash data analysis, collision diagrams, and safety performance functions can be employed to identify high-risk areas and recommend safety

improvements, such as curve realignment, intersection redesign, or installation of safety barriers.

- v. Environmental Impact Assessment: Environmental impact assessment techniques are employed to analyze the potential environmental impacts of the road design. This includes evaluating factors such as air quality, noise levels, water resources, flora, fauna, and cultural heritage. Data analysis methods such as modeling, impact matrices, and multi-criteria analysis can be used to quantify and evaluate the environmental impacts, allowing for informed decision-making and the incorporation of mitigation measures into the road design.

By utilizing these data analysis techniques, the route survey project at Okuo-Ovo Village can gain valuable insights and make informed decisions regarding road design, alignment, safety measures, and environmental considerations. The results of the analysis contribute to the development of a well-planned and optimized road network that meets the needs of the community while considering various factors affecting the project.

CHAPTER FOUR

4.0 INTRODUCTION

This chapter is concerned with the presentation of data obtained and designs drawn from obtained data from the route survey of the Okuo-Ovo road at Jesse. The results are presented in tabular form and figures. The study employed the use of road design with AutoCAD Civil 3D and its rule based design, rule violation warnings and design checks.

4.1 RESULT AND DISCUSSION

The project focused on the critical aspects of route surveying and road design, employing the versatile and powerful tool, AutoCAD Civil 3D. In this discussion, we will delve into the key findings and outcomes of the project, highlighting its significance in the field of civil engineering and infrastructure development.

4.2 RESULT

Table 4.1 shows the coordinates of the points picked during the route survey of Okuo-Ovo road.

	Eastings	Northings	Elevation
0	804825.8	649903.9	70.626
1	804842.2	649891.3	70.675
2	804854.1	649884	70.75
3	804852.2	649881.7	70.738
4	804870.3	649874.5	70.656
5	804867.5	649870.7	70.82
6	804884.4	649864.8	70.42
7	804885.6	649866.3	70.392
8	804901.4	649856.1	70.347
9	804919.3	649848.9	70.193
10	804928.3	649847.4	70.141
11	804926.5	649844.7	70.114
12	804942.9	649833.8	70.053
13	804960.1	649824.2	69.988
14	804960.9	649827.3	70.071
15	804973.8	649818.1	69.989
16	804984.1	649811.7	69.914
17	804984.9	649813.4	69.936
18	805004.1	649802.5	69.846

19	805025.5	649790.2	69.107
20	804807.7	649687	68.81
21	804817.3	649705.4	68.799
22	804826.9	649722.5	68.884
23	804828.8	649721.1	69.011
24	804836.7	649739.6	68.975
25	804845.2	649757.4	69.092
26	804853.6	649774.3	69.28
27	804862.6	649792	69.447
28	804870.2	649808.9	69.636
29	804878	649825.8	69.822
30	804886.9	649842.6	70.111
31	804976	649958	70.303
32	805023.2	650057.4	67.646
33	805012.1	650044.3	67.757
34	805001.3	650029.3	67.948
35	804989.9	650014.6	68.148
36	804979.8	649999.1	68.647
37	804971.4	649981	69.157
38	804974.2	649968.5	69.886
39	804992.5	649963.5	69.768
40	805010.1	649959.2	69.781
41	805027	649954.7	69.674

42	805043.5	649949.7	70.245
43	805022.2	649956.2	69.825
44	805068.9	649937.4	69.826
45	805068.6	649940.5	69.24

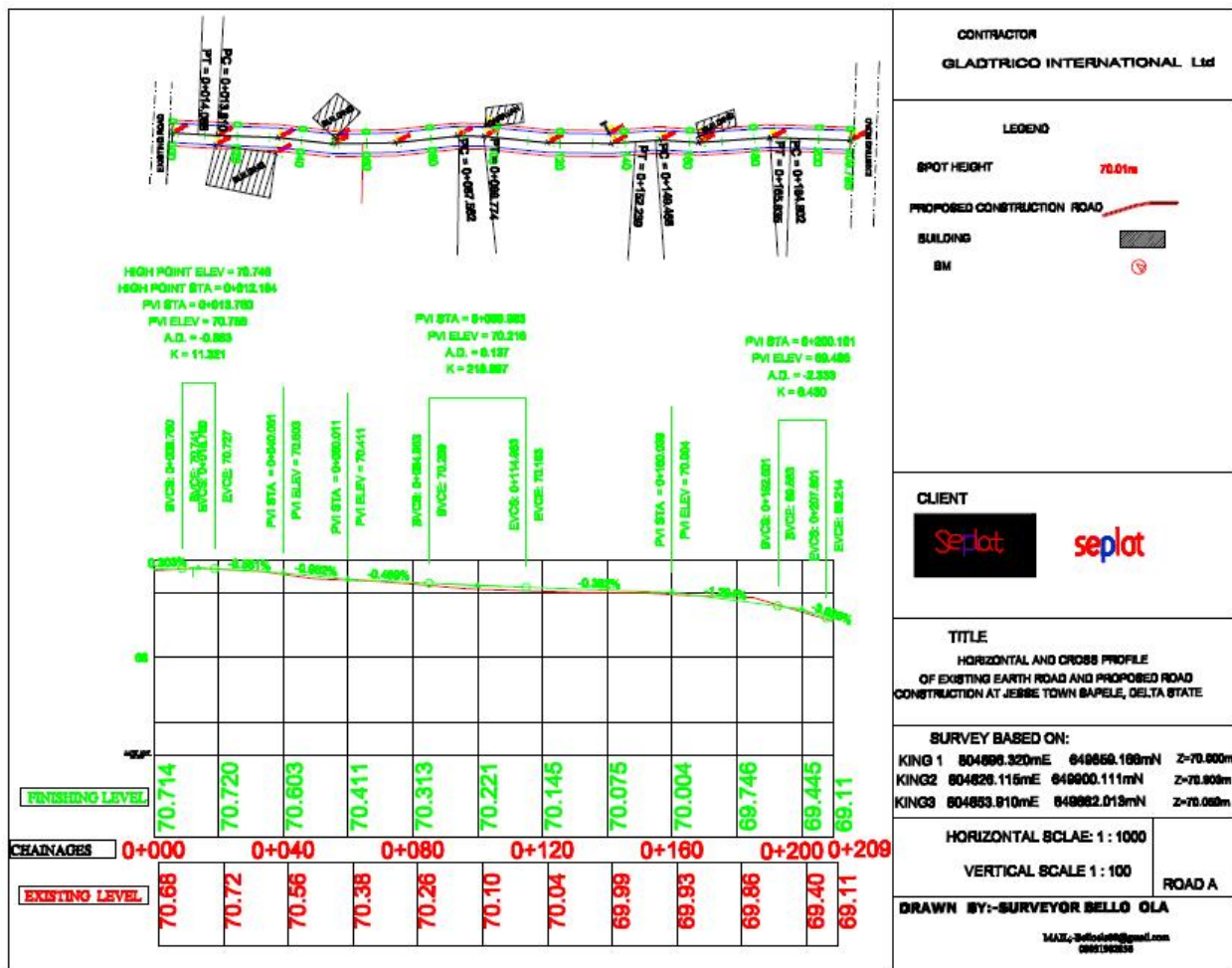


Fig 4.1 Horizontal and cross profile design of existing and proposed road at Jesse, Sapele, Delta State (road A).

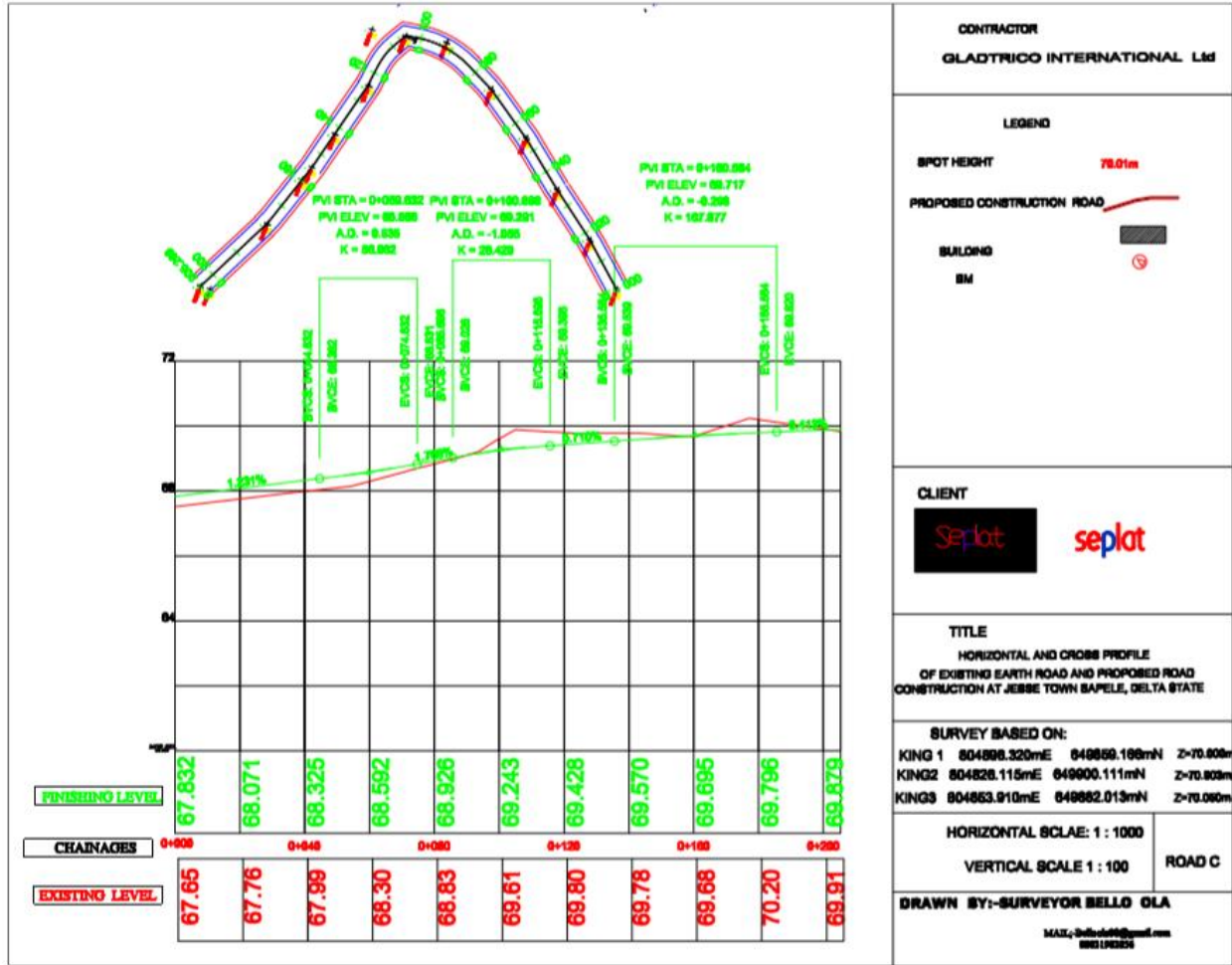


Fig 4.3 Horizontal and cross profile design of existing and proposed road at Jesse, Sapele, Delta State (road C).

4.3 DISCUSSION

The project centered on the crucial aspects of conducting a route survey and subsequently designing a road network in Jesse Town. The discussion below elaborates on the traversing procedures employed during the survey and the Civil 3D design procedures used to create a comprehensive road design plan for the town.

Traversing Procedures:

The project began with the collection of essential data about the existing terrain and geographical features in and around Jesse Town. This data included topographic information, land use patterns, and existing infrastructure.

To ensure accuracy in the survey, control points were established at strategic locations across Jesse Town. These control points served as reference markers for subsequent measurements and allowed for precise geospatial positioning.

Field measurements were carried out using advanced surveying equipment such as total stations and GPS devices. These instruments helped in capturing precise coordinates, elevations, and distances, enabling the creation of an accurate topographic map.

Traversing techniques were employed to measure distances and angles between control points, forming the basis for creating a connected network of surveyed points. Additionally, leveling surveys were conducted to determine the elevation differences across the town's terrain.

Once the field data was collected, it was processed using specialized software. Traversing data was adjusted to minimize errors, and topographic maps were generated, providing a comprehensive overview of the terrain's characteristics.

Civil 3D Design Procedures:

The processed survey data, including coordinates and elevation information, were imported into AutoCAD Civil 3D. This software serves as a powerful platform for civil engineering design and analysis.

Using Civil 3D, engineers designed the road's horizontal alignment. The software facilitated the creation of smooth curves and transitions while adhering to design standards and regulatory requirements.

Civil 3D enabled the development of the road's vertical profile, taking into account factors such as grades and slopes. This ensured that the road would meet safety and usability standards.

The software's cross-section design tools were employed to define the road's width, the placement of lanes, shoulders, and drainage systems. It allowed engineers to visualize how the road would interact with the existing terrain.

Civil 3D automatically calculated quantities of materials required for construction, including asphalt, gravel, and drainage infrastructure. This feature aided in cost estimation and project budgeting.

The 3D modeling capabilities of Civil 3D allowed for the creation of realistic visualizations of the proposed road. Stakeholders could view how the road would fit into the landscape, enhancing communication and decision-making.

Civil 3D facilitated the creation of detailed engineering plans, including plan sheets, profiles, and cross-sections. These documents serve as blueprints for construction contractors to follow.

CHAPTER FIVE

5.0 CONCLUSION

The successful culmination of the route survey and road design project at Jesse Town demonstrates the synergy between traditional surveying techniques and modern software solutions like Civil 3D. The project's emphasis on data precision, terrain understanding, and efficient design processes lays the groundwork for safer, more sustainable, and economically viable road infrastructure.

The impact of this project extends beyond the scope of Jesse Town. It sets a precedent for future infrastructure projects, emphasizing the importance of accuracy, efficiency, and stakeholder communication. By embracing advanced technology and combining it with tried-and-true surveying methodologies, the project paves the way for a brighter and more connected future for Jesse Town, showcasing the potential of modern civil engineering practices.

An initiative that bridges the gap between urban growth and infrastructure planning is the route survey and road design for Jesse Town. We have not only built a safe and accessible road but also contributed to the general growth and prosperity of Jesse Town by addressing the unique demands and concerns of the community. This undertaking highlights the value of sustainable, people-centered infrastructure in the contemporary world and serves as an example of the power of intelligent and inclusive urban planning. I believe that the insights discovered through this study will encourage comparable initiatives in urban development around the world, resulting in more resilient, connected, and thriving communities.

5.1 RECOMMENDATION

The successful completion of the route survey and road design project in Jesse Town is a significant milestone in enhancing local infrastructure. To ensure the long-term effectiveness and sustainability of the project, the following detailed recommendations are provided:

Regular Maintenance Protocol:

Establish a comprehensive maintenance schedule that includes regular inspections, repairs, and upkeep of the road. Implement routine maintenance to address issues like potholes, damaged signage, and faded road markings promptly. Regular maintenance will extend the road's lifespan and ensure safety for users.

Environmental Impact Monitoring:

Continue to monitor the project's environmental impact even after completion. Develop a system for periodic assessments to evaluate any ecological changes caused by the road. Implement mitigation measures if necessary, such as erosion control or habitat restoration.

Traffic Management and Safety Measures:

Develop a comprehensive traffic management plan that adapts to changing traffic patterns. Install adequate signage, lighting, and traffic calming measures as needed. Regularly assess the road's safety performance and make adjustments accordingly.

Future-Proofing and Expansion:

Anticipate future growth and development in Jesse Town. Design the road with scalability in mind to accommodate increased traffic and urbanization. Consider options for adding lanes, bike lanes, or pedestrian walkways to meet evolving needs.

Periodic Survey Updates:

Regularly update the route survey data to reflect any changes in the landscape or land use. This will provide accurate information for future planning, maintenance, and expansion projects.

Green Infrastructure Integration:

Explore opportunities to incorporate green infrastructure elements along the road, such as sustainable landscaping, stormwater management features, and energy-efficient lighting. These initiatives enhance the road's environmental sustainability.

Performance Reviews and Assessments:

Establish a framework for regular performance reviews and assessments of the road's functionality. Evaluate factors such as traffic flow, road condition, and community satisfaction. Use the findings to make informed improvements.

Contingency Budgeting:

Maintain a contingency fund to cover unexpected repairs or emergencies. Having financial reserves ensures the road's continued operation during unforeseen circumstances.

Collaboration with Local Authorities:

Foster collaboration with local government bodies, transportation agencies, and relevant stakeholders. Coordinate efforts to maximize resources, address emerging issues, and implement long-term strategies effectively.

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APPENDIX

TRANSFEREING HEIGHT USING AUTOMATIC LEVEL ON SITE



SAND FILLING STAGE OF ROAD CONSTRUCTION



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