



# A Review Study Of Total Station And Its Use In Plotting An Existing Building

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**Abstract:** A land survey was conducted using a Total Station, an advanced digital surveying instrument that integrates angle measurement, distance computation, and data recording within a single system. The objective of this study was to provide practical exposure to modern surveying techniques and digital data processing. The work involved essential operations such as horizontal and vertical distance measurement, angle observation, area determination, and preparation of a topographical layout of the site. The use of the Total Station significantly improved accuracy, efficiency, and reliability compared to conventional surveying methods by reducing human errors and enhancing data quality. This practical exercise successfully linked theoretical knowledge with field application, emphasizing the importance of digital surveying technologies in contemporary civil engineering and infrastructure development.

**Index Terms:** Total Station, Land Survey, Civil Engineering, Topographic Mapping, Field Data Collection, Geospatial Measurement, Digital Surveying, Campus Layout.

## I. INTRODUCTION

### 1.1 Importance of Surveying in Civil Engineering

Surveying is the foundation of civil engineering projects. It determines positions of points on the Earth's surface and provides essential data for planning, design, and construction. Accurate surveying ensures correct alignment, elevation, and positioning of structures such as roads, bridges, and buildings. It also supports land management, GIS mapping, and urban development.

## 1.2 From Traditional to Modern Surveying Methods

Early surveys used chains, tapes, and compasses, which were slow and prone to errors. The invention of Electronic Distance Measurement (EDM) and later the Total Station revolutionized surveying by combining angle and distance measurement with computerized data storage.



Fig 1 : Conventional and Modern Surveying Instruments

### 1.3 Objectives of the Project

- Conduct a topographical survey of the plot using a Total Station.
- Measure distances, angles, and elevations precisely.
- Establish control points and prepare contour maps.
- Compare modern and traditional methods in terms of efficiency and accuracy.

### 1.4 Survey Site Overview

The surveyed area includes academic buildings, roads, and open spaces with mostly flat to gently sloping terrain. Control points were fixed for visibility and accuracy. Data were collected and processed digitally to produce contour and layout maps useful for future campus development.

### 1.5 Scope and Relevance

The Total Station provides sub-centimeter accuracy, rapid data collection, and direct computer integration. It is highly applicable in construction layout, road alignment, and land subdivision. Academically, it bridges theoretical knowledge with practical skill and promotes sustainable, error-free engineering practices.

### 1.6 Teamwork and Communication

Each team member had defined roles operator, recorder, and assistant ensuring accuracy and efficiency. Continuous coordination and feedback were essential for reliable results and safe field operations.

## II. LITERATURE REVIEW

### 2.1 General

Modern civil engineering demands high-precision and rapid surveying methods. J. Sree Naga Chaitanya et al. (2023) stated that Total Station instruments improve speed and accuracy compared to traditional tools by combining distance and angular measurements in a single device. Total Stations provide efficient data collection, minimize human errors, and simplify both field and office work.

## 2.2 Case Study

With growing urban development, traditional surveying shows limits in accuracy and efficiency. Integrating Total Station and drone technology enhances spatial data collection and mapping reliability.

## 2.3 Critical Appraisal

Amirthavarshini K. et al. (2019) analyzed transformation of local survey data into real-world coordinates using Georeferencing, Spatial Adjustment, and Champ tools. Among these, the Champ tool preserved the highest positional accuracy. The study also confirmed that indirect leveling with Total Stations provides sufficient precision for large-scale works such as roads, airports, and city projects.

### Summary:

Literature shows that Total Station technology greatly improves efficiency, precision, and data management in surveying. Its integration with drones and GIS ensures faster, reliable, and cost-effective surveying suited to modern infrastructure development.

## III. SURVEYING INSTRUMENTS AND SOFTWARE

### 3.1 Introduction

Accurate surveying depends on the precision and reliability of instruments and data-processing software. In this project, the Sokkia CX-105 Total Station was used along with essential accessories like a tripod, reflector prism, and measuring staff. The data collected was processed using Sokkia Link and AutoCAD 2020 to generate topographical and layout maps.

### 3.2 Instruments Used

The Sokkia CX-105 Total Station combines a theodolite and EDM system with onboard data storage and computation, offering high accuracy and efficiency in fieldwork.



Fig 2 : Parts Of Total Station

**Key Features:**

- **High precision:** Angular accuracy of 5" and distance accuracy of  $\pm(2 \text{ mm} + 2 \text{ ppm})$ .
- **Range:** Up to 4,000 m with prism and about 400–500 m in reflectorless mode.
- **Digital storage:** Automatic data recording reduces manual error.
- **User-friendly:** LCD display, intuitive controls, Bluetooth and USB connectivity.

The tripod served as a stable platform for the Total Station, ensuring proper leveling and minimizing vibration. Its adjustable legs and locking mechanisms allowed accurate instrument setup on uneven terrain.



Fig 3 : Total Station

**3.3 Software Used**

**Sokkia Link** software was used for downloading, processing, and converting field data from the Total Station. It allows coordinate computation, error checking, and easy export of data to CAD or GIS-compatible formats. In this project, it acted as the bridge between field data and AutoCAD for plotting maps and contours.



Fig 4 : Autocad 2020

**AutoCAD 2020** was used for drafting and visualizing the survey results.

**Key Features:**

- Precise 2D drafting and 3D modeling of site data.
- Direct data import from Sokkia Link for accurate plotting.

It was used to produce final topographical maps, contour layouts, and professional drawings for analysis and presentation.

### 3.4 Integration of Instruments and Software

The combination of Sokkia CX-105, Sokkia Link, and AutoCAD 2020 created an efficient digital workflow from field measurement to final map generation. This integration provided:

- High accuracy and minimized human error.
- Faster data collection and processing.
- Digital storage and easy data sharing.
- Compatibility with GIS and mapping tools for future applications.

#### Summary:

The effective integration of advanced instruments and software enhances survey accuracy, reduces time, and ensures high-quality outputs. The use of the Sokkia CX-105 with Sokkia Link and AutoCAD demonstrates the transition toward fully digital and efficient surveying practices in modern civil engineering.

## IV. SURVEY METHODOLOGY

### 4.1 Introduction

The survey methodology adopted in this project aimed to achieve high accuracy in data collection, processing, and topographical representation using the Sokkia CX-105 Total Station. Each operation from setting up the instrument to generating final maps was carried out systematically following standard surveying procedures.

### 4.2 Setting Up and Leveling the Instrument

The Total Station was mounted on a sturdy tripod at the designated station point. The height of the instrument was adjusted to eye level for convenient operation, and the tripod legs were firmly fixed in the ground for stability.

### 4.3 Labeling and Identifying Survey Points

Before commencing field measurements, all important features such as roads, boundaries, buildings, and benchmarks were marked on the ground.

Each point was labeled with a unique code (e.g., TP1 for Traverse Point 1, BM for Benchmark) for easy identification and to maintain systematic data entry during observation and processing.

#### 4.4 Recording of Observations

Once labeling was completed, the Sokkia CX-105 Total Station was used to record horizontal angles, vertical angles, and slope distances. The data comprising coordinates (X, Y, Z), slope distances, and angles were stored automatically in the Total Station's internal memory. This digital recording minimized manual errors and improved data reliability.



Fig 5 : Recording Points

#### 4.5 Establishing Control Points and Orientation

Control points were established at known locations to provide reference for all subsequent survey measurements. These points were connected through traversing, ensuring a consistent control network across the site.

#### 4.6 Data Extraction and Processing

After completing the fieldwork, recorded data were extracted from the Total Station using a USB cable or memory card. The files, generally in SDR format, contained point IDs, coordinates, and instrument setup details.

These files were transferred to a computer for processing, marking the shift from field data collection to office work.

#### 4.7 Converting SDR to DXF Using Sokkia Link

The field data were processed in Sokkia Link software, which serves as an interface between the Total Station and CAD platforms. The SDR files were converted into DXF format, compatible with AutoCAD.

#### 4.8 Preparation of Final Drawings in AutoCAD

The converted DXF file was imported into AutoCAD 2020, where detailed DWG drawings were created. Survey points were connected according to their codes to form boundaries, contours, and key features such as roads, buildings, and vegetation zones.

## 4.9 Summary

The methodology ensured precision and efficiency at every stage from field data acquisition to final drawing preparation.

## V. FIELD WORK EXECUTION

### 5.1 Overview

The fieldwork execution formed the core of this project, where the Sokkia CX-105 Total Station was used to conduct a precise topographical survey of the site. The process involved control point selection, on-site measurements, data extraction, and layout preparation. Each stage was executed with accuracy, ensuring reliable and reproducible results.



Fig 6 : Total Station Setup and Leveling

### 5.2 Field Work Execution

#### 5.2.1 Control Points:

Three permanent control points were selected at strategic and stable locations across the site for reference. A benchmark with a known elevation was established to maintain uniform height measurements. Each control point was coded (e.g., CP1, CP2) and marked to ensure systematic data organization.

#### 5.2.2 Instrument Setup and Measurements:

The Total Station was mounted on a tripod, leveled using the electronic bubble, and centered precisely using the optical plummet. Measurements of angles and distances were taken with the EDM system, and 3D coordinates (X, Y, Z) were computed automatically. Data was digitally stored to minimize manual errors.

#### 5.2.3 Field Challenges:

The main challenges included uneven terrain, obstructions (trees, poles, buildings), and environmental factors such as glare and wind. These were handled by using reflectorless EDM mode and stabilizing the setup. Data organization and labeling were also crucial to avoid post-processing errors.

## VI. DATA HANDLING AND CONVERSION

### 6.1 Overview

After the field survey, the data stored in the Total Station was extracted using a USB interface. The SDR (Survey Data Recorder) file contained all measured data, including angles, slope distances, coordinates, and point identifiers.

### 6.2 Conversion to DXF:

The SDR files were imported into Sokkia Link software, where errors or missing points were corrected. The verified data was then exported as a DXF file, compatible with AutoCAD. This conversion ensured accurate transfer of coordinates and attributes from the Total Station to CAD platforms.

### 6.3 Data Integrity:

To maintain reliability, multiple data backups were created on laptop, cloud, and external drives. All files were properly named and timestamped. Verification against control points ensured consistency and error-free integration into design software.

## VII. Drawing and Layout Preparation

### 7.1 Importing DXF into AutoCAD:

The DXF file was imported into AutoCAD 2020, scaled appropriately, and verified by comparing known distances with field values. This confirmed that all points were correctly plotted.

### 7.2 Creating Layout:

Points were connected to form boundaries, roads, and building footprints using AutoCAD tools. Layers were used to differentiate features such as roads, buildings, and open areas. Contours and topographical details were included to represent elevation variations.

### 7.3 Annotation and Final Output:

Labels for roads, buildings, and boundaries were added, along with a north arrow and scale bar for orientation. The final drawing was saved as a DWG file, providing an accurate and organized digital representation of the surveyed area suitable for academic, planning, and construction purposes.

## VIII. RESULTS AND OBSERVATIONS

The final stage of the project involved analyzing field data and verifying the accuracy of the plotted layout prepared from Sokkia CX-105 Total Station measurements. This ensured that all surveyed features were correctly represented and met professional standards.

## 8.1 Summary of Collected Data

The Total Station survey provided accurate horizontal and vertical angles, slope distances, and elevations (X, Y, Z). Each point was uniquely coded, covering buildings, roads, playgrounds, and boundaries. Data stored in SDR format was converted to DXF and imported into AutoCAD 2020, forming the base for layout generation and mapping.

## 8.2 Accuracy of Plotted Layout

The AutoCAD layout was verified against field measurements.

- **Control Points:** Digital and field distances matched within  $\pm 2-5$  mm, ensuring precision.
- **Roads & Boundaries:** Linear and curved alignments accurately represented the site.
- **Elevations:** Benchmark and contour levels corresponded with field values.
- **Annotations:** All features were labeled with consistent layers and scaling.

## 8.3 Overall Observations

The final DWG layout accurately reflected the surveyed area with excellent alignment and clarity. Integration of Total Station data with AutoCAD ensured high accuracy and professional-quality mapping, confirming the effectiveness of the adopted surveying procedure.

## IX. CONCLUSION

The survey of the campus area using the Sokkia CX-105 Total Station was successfully completed with high accuracy and efficiency. The project involved control point establishment, precise field measurements, data extraction, and digital layout preparation in AutoCAD 2020. All collected data were processed and verified to ensure positional and elevation accuracy within acceptable limits. The final DWG layout provides a clear and reliable representation of the site, suitable for academic, planning, and design purposes.

Overall, the study demonstrated the effectiveness of Total Station surveying in producing accurate spatial data and highlighted the importance of systematic fieldwork, data handling, and digital processing in modern surveying practices.

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