"PRECISION LAYOUT PLANNING OF AUDITORIUM STRUCTURES USING TOTAL STATION"

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ABSTRACT

Getting the layout exactly right is the biggest challenge when building an auditorium, where complex, curved shapes, perfect sightlines, and precise acoustics are non-negotiable. Using old-school surveying methods often leads to small errors that add up, threatening the entire project's alignment and functionality. This project highlights how using Total Station technology solves these issues, ensuring precise layout, staking, and vertical alignment for tricky elements like raked seating, curved walls, and long-span trusses.

By bridging the gap between digital CAD designs and on-site reality, we achieved sub-centimeter accuracy when setting out column centers, gridlines, and steep seating slopes. The Total Station sped up the process, boosted efficiency, and provided far better accuracy than traditional manual methods. Ultimately, this approach proves that using digital surveying tools drastically reduces human error, making sure specialized, high-stakes building projects match the design perfectly.

Keywords: Total Station, Precision Layout, Auditorium Design, Construction Surveying, Site Staking, Structural Alignment.

1 INTRODUCTION

1.1 Background

Surveying is the art of determining the relative positions of points on, above or beneath the surface of the earth by means of direct or indirect measurements of distance, direction and elevation. It also includes the art of establishing points by predetermined angular and linear measurements. The application of surveying requires skill as well as the knowledge of mathematics, physics and to some extent astronomy.

Levelling is a branch of surveying the object of which is,

(i) To find the elevations of points with respect to a given or assumed datum and
(ii) To establish points at a given elevation or at different elevations with respect to a given or assumed datum. The first operation is required to enable the works to be designed while the second operation is required in the setting out of all kinds of engineering works. Levelling deals with measurements in a vertical plane.

1.1.2 Aim

TO implement precise and efficient layout planning on college ground of auditorium building using total station, enhancing accuracy in positioning and alignment of structural elements.

1.1.3 Objectives

- To understand the principles and functioning of a total station in surveying and construction Layout.
- To perform site reconnaissance and determine reference points and benchmarks.
- To carry out layout marking for various construction elements (e.g., foundation, columns, walls) using a total station.
- To compare the accuracy and efficiency of total station layout planning with traditional methods.

1.2 Primary Division of Survey

The earth is an oblate spheroid of revolutions, the length of its polar axis (12,713,800 metres) being somewhat less than that of its equatorial axis (12,756,750 metres). Thus, the polar axis is shorter than the equatorial axis by 42.95 kilometres. Relative to the diameter of the earth this is less than 0.34 percent. If we neglect the irregularities of the earth. The surface of the imaginary spheroid is a curved surface, every element of which is normal to the plumb line. The intersection of such a surface with a plane passing through the Centre of the earth will form a line continuous around the earth. The portion of such a line is known as 'level line' and the circle defined by the intersection is known as 'great circle'. Thus, the distance be-tween two points P and Q is the length of the arc of the great circle passing through these points and is evidently somewhat more than the chord intercepted by the arc [18].

Consider three points P, Q and R and three level lines passing through these points. The surface within the triangle PQR so formed is a curved surface and the lines forming its sides are arcs of great circles. The figure is a spherical triangle. The angles p, q and r of the spherical triangle are somewhat more than corresponding angles p, q and r of the plane triangle. If the points are far away, the difference will be considerable. If the points are nearer, the difference will be negligible [18].

As to whether the surveyor must regard the earth's surface as curved or may regard it is as plane depends upon the character and magnitude of the survey and upon the precision required.

Thus, primarily, surveying can be divided into two classes:

(1) Plane Surveying

(2) Geodetic Surveying.

1.2.1 Plane surveying

Plane Surveying is that type of surveying in which the mean surface of the earth is considered as a plane and the spheroidal shape is neglected. All triangles formed by survey lines are considered as plane triangles. The level line is considered as straight and all plumb lines are considered parallel. In everyday life we are concerned with small portions of earth's surface and the above assumptions seem to be reasonable in light of the fact that the length of an arc 12 kilometres long lying in the earth's surface is only 1 cm greater than the subtended chord and further that the difference between the sum of the angles in a plane triangle and the sum of those in a spherical triangle is only one second for a triangle at the earth's surface having an area of 195 sq. km [18].

1.2.2 Geodetic Surveying

Geodetic Surveying is that type of surveying in which the shape of the earth is taken into account. All lines lying in the surface are curved lines and the triangles are spherical triangles. It, therefore, involves spherical trigonometry. All geodetic surveys include work of larger magnitude and high degree of precision. The object of geodetic survey is to determine the precise position on the surface of the earth, of a system of widely distant points which form control stations to which surveys of less precision may be referred [18].

1.3 Classification

Surveys may be classified under headings which define the uses or purpose of the resulting maps.

1.3.1 Classification Based Upon the Nature of the Field Survey

(1) Land Surveying

(i) Topographical Surveys:

This consists of horizontal and vertical location of certain points by linear and angular measurements and is made to determine the natural features of a country such as rivers, streams, lakes, woods, hills, etc. and such artificial features as roads, railways, canals, towns and villages.

1.2.2.1 Cadastral Surveys:

Cadastral surveys are made incident to the fixing of property lines, the calculation of land area, or the transfer of land property from one owner .to another. They are also made to fix the boundaries of municipalities and of State and Federal jurisdictions.

1.2.2.2 City Surveying:

They are made in connection with the construction of streets, water supply systems, sewers and other works.

(2) Marine or Hydrographic Survey:

Marine or hydrographic survey deals with bodies of water for purpose of navigation, water supply, harbour works or for the determination of mean sea level. The work consists in measurement of discharge of streams, making topographic survey of shores and banks, taking and locating soundings to determine the depth of water and observing the fluctuations of the ocean tide.

(3) Astronomical Survey:

The astronomical survey offers the surveyor means of determining the absolute location of any point or the absolute location and direction of any line on the surface of the earth. This consists in observations to the heavenly bodies such as the sun or any fixed star [18].

1.3.2 Classification Based on the Object of Survey

(1) Engineering Survey:

This is undertaken for the determination of quantities or to afford sufficient data for the designing of engineering works such as roads and reservoirs, or those connected with sewage disposal or water supply.

(2) Military Survey:

This is used for determining points of strategic importance.

(3) Mine Survey:

This is used for the exploring mineral wealth.

(4) Geological Survey:

This is used for determining different strata in the earth's crust.

(5) Archaeological Survey:

This is used for unearthing relics of antiquity [18].

1.3.3 Classification Based on Instruments Used

An alternative classification may be based upon the instruments or methods employed, the chief types being:

(1) Chain survey

(2) Theodolite survey

(3) Traverse survey

(4) Triangulation survey

(5) Tachometric survey

(6) Plane table survey

(7) Photogrammetric survey

(8) Aerial survey

1.4 Scales

The area that is surveyed is vast and, therefore, plans are made to some scale. Scale is the fixed ratio that every distance on the plan bears with corresponding distance on the ground. Scale can be represented by the following methods:

(1) One cm on the plan represents some whole number of metres on the ground, such as 1cm = 10 m etc. This type of scale is called engineer's scale.

(2) One unit of length on the plan represents some number of same units of length on the ground, such as 1/1000 etc. This ratio of map distance to the corresponding ground distance is independent of units of measurement and is called representative fraction. The representative fraction (abbreviated as R.F.) can be very easily found for a given engineer's scale.

For example, if the scale is,

1cm = 50m

R.F. = 1/(50X100)

= 1/5000.

The above two types of scales are also known as numerical scales.

(3) An alternative way of representing the scale is to draw on the plan a graphical scale. A graphical scale is a line sub-divided into plan distance corresponding to convenient units of length on the ground.

If the plan or map is to be used after a few years, the numerical scales may not give accurate results if the sheet or paper shrinks. However, if a graphical scale is also drawn, it will shrink proportionately and the distances can be found accurately. That is why, scales are always drawn on all survey maps [18].

1.5 Total Station

The total station is an improvised version of modern surveying instruments such as EDM-Electronic distance measurement, auto level and digital level. Total station is a combination of electronic theodolite and electronic distance measurement (EDM).

This combination makes it possible to determine the co-ordinates of reflector by aligning the instrument's cross hair on the reflector and simultaneously measuring the vertical and horizontal angles and slope distances. On board microprocessor in the instrument, takes care of recording, readings and the necessary computations. The data can be easily transferred to a computer where it can be used to generate map.

1.5.1. Component Parts of Total Station

Like the Auto level and Theodolite, the Total Station is also used with tripod for mounting it. It also sometime work with a reflector (usually a glass prism fitted on a tripod) to reflect the signals of EDM.

Fig. 1. Front view of a Total Station

Fig. 2. Back view of a Total Station

Carry Handle: It is for easy and save movement of the instrument from one position to another.

Alidade: It is to roughly align the instrument towards the target.

Objective Lens: It catches the object being sighted and magnifies the object.

Eyepiece: It is located at the viewing end of the telescope, it can be turned to bring the crosshairs into focus.

Focusing Knob: It is to focus the target when seeing it from the eyepiece.

Vertical and Horizontal Clamps: They are to lock the instrument towards a certain point. When engaged they restrict the movement of Telescope on their respective axis.

Vertical and Horizontal Tangent Screws: They are used to move the crosshairs on their respective axis when seen through they eyepiece.

Leveling Screws: It allows adjustments to be made to ensure the instrument is level.

Base Plate: It is the area to which the instrument level attaches on the tripod.

Tripod: A tripod is a three-legged stand, important in providing the foundation for auto levels and other leveling instruments. It is usually made up of Aluminium for the sake of lightness.

Reflector: It is used to reflect the signals sent by the EDM it is usually a glass prism fitted on a tripod.

Control Panel: The control panel of a Total Station consists of a keyboard and an LCD. It is used as a medium of interface between the user and the instrument. The user enters input by the keyboard and the instrument gives the output on the LCD screen.

Fig. 3. Control Panel of a Total Station

Keyboard: The keyboard in the control panel of a total station contains a number of keys used for different purposes. The functions of some important keys are mentioned below:

ON/OFF Key: It is used to ON and OFF the instrument.

Soft Keys: The control panel of a total station contains 4 soft keys which are used to select different functions of the total station.

Cursor Keys: They are used to move the cursor up-down and left-right on the screen.

Function Key: It is used to change pages on the LCD screen of the control panel.

Shift Key: It is used to change the type of reflector.

Space Key: It is used to enter a space.

Back Space Key: It is used to delete a character.

Escape Key: It is used to exit from a mode.

Enter Key: It is used to enter data.

Alpha/Num Key: It is used to switch between numbers and alphabets.

View Key: It is used to see the data in the current job.

Note Key: It is used to enter a note.

Screen: The control panel of a Total Station also contains a LCD screen which shows outputs to the user. In Total Station there are 3 pages and each page contains 4 different function. The basic detail of these functions are given below.

REC: It transfers the instrument to REC mode.

M.DISP: It is to select the Distance mode.

CNFG: It is for the settings of parameter.

READ: It is to measure the distance.

0SET: It makes the horizontal angle at 0°.

H.ANG: It is used to set horizontal angle to a specific value.

AIM: t is used to check the return signal.

TILT: It is called "Tilt Angle Display" and used to level the instrument.

PPM: It means "Parts Per Million" and is used for atmospheric correction.

REM: It is used for the REM measurement.

MLM: It is used for the measurement of Missing Line".

S-O: It is for Setting-Out Measurement.

Operation:-

Mounting: Just like the Auto Level and Theodolite, Total Station also needs to be mounted on the tripod before starting. Therefore for that purpose, the instrument is placed on the head of the tripod carefully such that the nuts under the instrument perfectly aligning with the bolts present on the head of the tripod and then the bolts are tightened with the nuts completing the mounting process.

Levelling: Unlike Auto Level and Theodolite, the Total Station does not require the Circular Level for the levelling of the instrument as it already has an automatic built-in option for that purpose. The Surveyor only needs to move the "Page-2" on the screen of the control panel and select the option "TILT (Tilt Angle Display)"a bubble just like one in the circular level showed up on the screen and the user can then easily level the instrument by adjusting the legs of the tripod or by moving the levelling screws of the instrument.

Usage: Once the Total Station is mounted and levelled properly it can then be used for quite a number of operations such as the measurements of horizontal and vertical angles, vertical and horizontal and also slope distances between two or more points only by pressing certain keys and by selecting appropriate functions for the job in almost no time.

2. LITERATURE REVIEW

2.1 Introduction:

This literature review is a comprehensive summary of previous research on 'Total Station'. Several studies and research papers have highlighted the role of total stations in achieving higher precision in layout planning. Compared to traditional methods, total stations offer faster data collection, reduced human error and integration with CAD and GIS software, which allows for real-time data processing and improved project outcomes. The literature emphasizes the impact of total stations in various applications including building construction, road alignment, topographic surveys and infrastructure development.

2.2 Review of Literature:

1. **Emmanuel OK, Comparison of traditional survey methods and structure from motion (UAV drone) in topographical mapping, 25 Jan 2025:**

The paper compares traditional survey methods, including total stations, GNSS (Global Navigation Satellite Systems) and levelling, with Structure from Motion using Unmanned Aerial Vehicles (UAVs) in topographical mapping. Traditional methods are known for their high accuracy, reliability and suitability for small-scale projects, but they are time-intensive, labour-heavy and limited in accessibility, particularly in rugged terrains. In contrast, UAV- SFM technology offers rapid data collection, cost-effectiveness for large areas and the ability to access difficult terrains, although it faces challenges like weather dependence, potential regulatory hurdles and accuracy variability. The study emphasizes the complementary nature of these approaches, suggesting that a hybrid method combining traditional techniques with UAV-SFM can optimize surveying in diverse scenarios, addressing the evolving demands of geospatial science and mapping.

2. **Xuan Li, Research on the application of GPS, Total Station and CAD Technology in Architectural Grid, 3 Nov 2024:**

In the field of contemporary construction project management, the integrated operation of global positioning system, measurement station equipment and computeraided design technology has become a core tool to improve construction efficiency and accuracy. This article analyzes the application of these advanced technologies in building layout and discusses their practical effectiveness in on-site surveying, construction positioning and deformation monitoring. Global positioning system technology can provide accurate geographic location information, improving the efficiency of construction site surveying and construction positioning. The measuring station equipment plays a crucial role in monitoring construction progress, ensuring construction quality and conducting safety supervision. Computer aided design technology, with its efficient design capabilities and structural analysis functions, provides strong support for the rapid updating of architectural design and the improvement of construction accuracy. The development of the construction industry cannot be separated from technological innovation, especially the widespread application of technologies such as Global Positioning System (GPS), central station equipment and Computer Aided Design (CAD), 40 which have improved the efficiency and accuracy of planning, construction and supervision of construction projects.

3. **M.K.Sameer, Evaluation of accuracy GPS and automatic level instruments in topographic surveying, Dec 2022:**

In this paper the study area is a city located in eastern Iraq, on the side of the Tigris River, about 160 kilometres (99 miles) southeast of Baghdad. The goal of the research was to compare a GPS and an automatic level instrument in computing elevations which has been practiced in the district of the Technical Institute of Anbar. The result of this work is shown that the convenient work by GPS system in surveying. In addition to this, a lot of researches were done about contour map creation and these studies depended on different data resources and methods. But those studies did not compare the resulted data of the mentioned instruments.

Finally, the accuracy of the results also investigated in line with the resolution of digital elevation model and the slope of the topography. The findings of the study show the effect of the source data, resolution and ground control point distribution. Data are collected by using a GPS receiver (Garmin 62S0). Through this process the points are selected randomly in the study area, the coordinates and elevations were taken for each point with specific times of observation.

4. **Er. Joga Singh, A Technological Review of Modified Theodolite Instrument: Phototheodolite, Sept 2021:**

In this paper, "A Technological Review of Modified Theodolite Instrument: Phototheodolite," the authors review advancements in theodolite technology, focusing specifically on the development of photo theodolites. They discuss how these modern instruments integrate image sensors with traditional theodolite features to improve the precision of geodetic measurements. The paper outlines the historical evolution of theodolites, detailing their progression from 19th-century designs to contemporary devices used for measuring static and dynamic displacement of civil engineering structures, such as bridges and dams. The authors examine how the incorporation of electronic distance measurement (EDM) technology and image processing methods enhance the accuracy and efficiency of surveying processes. They highlight the role of photo theodolites in monitoring changes in structures over time, especially under stress and deformation. The paper emphasizes the importance of proper maintenance for these instruments and advocates for the adoption of modern techniques in the field. Overall, the paper illustrates the significant advancements in surveying technology and their impact on ensuring the safety and functionality of both artificial and natural structures.

5. **R. Jaya Sankar, Advanced Survey, 5 May 2019:**

In this paper, the authors explore the application of Total Stations in civil engineering surveying, emphasizing their accuracy and efficiency in measuring distances, angles and coordinates for various construction projects. They present a comprehensive methodology that involves the use of advanced instruments such as GPS, GIS and drone aerial surveys to gather data on land features like lamp holes, trees and septic tanks. The paper details the process of conducting fieldwork with the Total Station, including the setup, measurement of horizontal and vertical distances and the direct storage of data. Following the fieldwork, the authors describe the office work phase, where the collected data is transferred to AutoCAD for creating 3D representations of the surveyed area. They outline the steps for saving and converting data from the Total Station to Excel format, ensuring that coordinates are organized for easy plotting. The authors also highlight the advantages of using Total Stations, such as quick setup, reduced manual operations and the ability to visualize land plots, ultimately concluding that these instruments significantly enhance the accuracy and efficiency of surveying tasks in civil engineering projects.

6. **Dr. Kannan. M, Evaluation of Land Surveying and Mapping using Total Station, GPS and GIS, 2019:**

The research focused on evaluating the effectiveness of two surveying methods, Global Positioning System (GPS) and Total Station, in conjunction with Geographic Information System (GIS) applications, specifically within a study area of 60,000 m² located in the Mu-Za district of Taipei City. The study aimed to assess land use changes over time by integrating measurements from both surveying methods into a GIS environment, ensuring that the data collected maintained high accuracy without gross errors. Various hardware and software tools were employed, including a Nikon D-80 camera for image capture, a Garmin Etrex GPS for position measurement, a Pentax R425VN Total Station for evaluating point clouds and ESRI arcgis for data visualization and analysis. The methodology encompassed processes of geotransformationand georeferencing, which were essential for converting local assumed coordinates into realworld coordinates, alongside the collection of non-spatial data to enrich the analysis. The precision of the measurements was evaluated using statistical methods such as root mean square (RMS) and standard deviation analysis. Ultimately, the findings highlighted the significance of employing these advanced surveying techniques for accurate mapping and enhanced environmental information within the specified area.

7. Gajanan Narwade, Introduction of Total Station, 2019:

The paper presents the Total Station as a sophisticated electronic surveying instrument that integrates Electronic Distance Measuring (EDM) technology with a theodolite, designed for precise horizontal and vertical measurements essential in modern surveying tasks. The setup process involves leveling a tripod, securely mounting the Total Station and focusing it on the survey point, with accuracy varying by model angular accuracy ranging from 1" to 20" and distance accuracy typically around +/- 10mm. Total Station is a compact instrument and weighs 50 to 55 N. Total Stations perform various functions, including detailed surveys, height measurement, area calculation, remote distance measurement and coordinate computation, making them applicable in detailed surveys, control surveys, setting out operations and resection. The authors conclude that total Stations significantly enhance surveying efficiency by automating measurements and data recording, reducing time and minimizing human error, thus advocating for their widespread adoption in modern surveying practices. The paper also cites various sources to support its findings and recommendations, highlighting recent technological developments in surveying equipment.

8. M. Nandhini Chella Kavitha, A Comparative Study of Conventional Surveying Techniques with Total Station and GPS, 1 Jan 2018:

Today advanced Surveying techniques are improving accuracy of measurements of distance, height, area and positional information of an area. The football ground from Karpagam Academy of Higher Education (KAHE) as sample from the study area. The ground is in rectangular shape. There are 8 pillars in the ground it is closed by the steel roof. Today advanced Surveying techniques are improving accuracy of measurements of distance, height, area and positional information of an area. Total station is an advanced instrument which is mainly used for measuring horizontal distance, slope distance, remote objects height and area of a land parcel now a days this instrument is majorly used for determining the land area information. It is possible to conduct survey with less man power and less time while using Total station. The aim of the study is to compare the land survey 36 results conducted by conventional methods with Total Station and GPS. The study area was measured using conventional methods like Chain, Tape, Plane Table and theodolite Total Station (TS) and Global positioning system (GPS). The collected data was processed in AUTO CAD and terracing. The results were compared and analysed. The campus will be measured using total station.

9. Patil Vilas, DGPS Based Digital Topographic Survey, 2018:

In this paper explains how a modern surveying method using Differential Global Positioning System (DGPS) was used to map the Tembhapuri Reservoir in Aurangabad, Maharashtra, India. Traditional survey methods are slow and require more workers. DGPS is faster, more accurate and cost-effective. DGPS uses two GPS receivers: one is fixed (base) and the other moves (rover). The method helps collect ground levels and map the reservoir area digitally. Surveys were done over several days in 2017 and 2018 using Trimble R-4 equipment. Data was processed using Trimble Business Center and ArcGIS software to create contour maps. The maps were used to calculate the storage capacity of the reservoir. The study showed that DGPS surveys are faster and more accurate than older methods. In conclusion, DGPS surveying is a reliable and efficient method for mapping large areas. It saves time and resources and is helpful for projects like dams, canals, and reservoirs.

10. Sagar G. Watke, Layout Planning by Using Advanced InstrumentTotal Station,2018:

The paper discusses how total stations are used in surveying. Total stations are advanced tools that help surveyors accurately measure distances, angles and heights. The paper explains how to set up a total station step by step. First, you need to place a tripod, then attach the instrument to it, aim it at points you want to measure and make sure it is level to get precise readings. Angles and distances are measured from the total station to points under survey and the coordinates (X, Y and Z or northing, easting and elevation) of surveyed points relative to the total station position are calculated using trigonometry and triangulation.

The authors also talk about different ways total stations are used, such as in construction for making detailed plans and checking the progress of building projects. They mention that total stations are more expensive than older surveying tools and that using them requires specific skills. The main goal of the study is to help people understand how to use total stations effectively to improve the accuracy and efficiency of surveying work. In simple terms, the paper highlights the importance of total stations in modern surveying and engineering practices.

11. Sanjeev Gill, To Experimental Study for Comparison Theodolite and Total Station, 3 march 2016:

The paper titled "To Experimental Study for Comparison Theodolite and Total Station" investigates and contrasts two fundamental surveying instruments, the theodolite and the total station, focusing on their operational principles, accuracy and practical applications in modern surveying. The study begins by detailing the functionalities and components of the theodolite, which is primarily used for measuring horizontal and vertical angles. It categorizes the theodolite into various types, such as Transit and Vernier and discusses its essential parts, like the telescope and vertical scale. Moving on to the total station, the paper highlights its advanced capabilities, which combine electronic theodolite functions with distance measurement, providing superior accuracy and 38 efficiency for modern survey tasks. The research further evaluates distinct surveying techniques, emphasizing the advantages of utilizing total stations over traditional theodolites through practical case studies. The findings showcase the significant improvements in measurement precision and time efficiency achieved through total station use. Additionally, the paper emphasizes the importance of equipment maintenance and advocates for the adoption of modern surveying techniques, ultimately concluding that embracing such advancements can greatly benefit urban planning and development initiatives.

12. Iulian Bratosin, Surveying Theodolite Between Past and Future, 2016:

In this paper "Surveying Theodolite between Past and Future," the authors look at how the theodolite, a tool used for measuring angles in surveying, has changed and improved over time. They start by discussing the history of the theodolite from its early versions in the 16th century to modern advanced models used in engineering. The paper explains different types of theodolites and their main parts, like telescopes, and how they work to measure angles accurately. It also compares traditional theodolites with new total stations that combine angle measurements with electronic distance measurements, making surveying more efficient. The authors highlight the benefits of using theodolites, such as their high accuracy and advanced features that help reduce errors. Overall, the paper shows the importance of theodolites in the past and their continued relevance in today's surveying practices. The theodolite became a modern, accurate instrument in 1787 with the introduction of Jesse Ramsden's famous great theodolite, which he created using a very accurate dividing engine of his own design (Turner 1983).

13. S.R. Saghravani, Accuracy Compression of RTK-GPS and Automatic Level for Height Determination in Land Surveying, 1 Sept. 2009:

This study compares the accuracy of Real-Time Kinematic GPS (RTK-GPS) and traditional automatic level methods for determining elevation in land surveying, conducted on a 16-hectare area at University Putra Malaysia. RTK-GPS, a modern technique using satellite signals and dual-frequency systems, offers fast and precise real-time positioning with vertical accuracy ranging between 0 to 10 centimeters, which is comparable to traditional levelling techniques. Despite its effectiveness, RTK-GPS can face signal obstructions from trees and buildings, affecting accuracy. The study used Trimble 5800 GPS receivers and automatic levels, comparing elevations measured by both methods across multiple points. Statistical analysis showed no significant difference between the two methods, validating RTK-GPS for reliable elevation measurement in suitable environments. Additionally, RTK-GPS was found to reduce manpower and time by up to 50% compared to traditional methods, making it suitable for projects requiring fast and flexible elevation data collection, especially in urban or semi-urban settings. The study concludes that RTK-GPS, when combined with traditional methods, provides an efficient and accurate surveying solution, though further research is suggested for high-precision applications in challenging terrains.

Conclusion: From all the above papers we studied, the use of total station for layout represents a significant advancement surveying and construction.

3. METHODOLOGY

3.1 Site Selection

For the purpose of our layout planning project, we selected the college playground as our site. The playground is conveniently back side of the college building, providing easy access for surveying instruments and personnel. The open and level nature of the area made it an ideal location for conducting layout planning activities using advanced surveying techniques.

3.1.1 Site Selection Procedure for Layout Planning

The selection of a suitable site for layout planning is a critical step in ensuring accurate and efficient surveying. For those removing bushes is a common part of site clearing during pre-field work. Identify which bushes need to be removed and which should be preserved.

After that the following procedure was adopted:

1. Conduct a Reconnaissance Survey

- Visit the site to understand terrain, accessibility and layout requirements.
- Ensure Clear Visibility.
- Elect a location with an unobstructed line of sight to known reference points.

2. Choose Level and Stable Ground.

- The ground should be firm and flat to allow accurate instrument setup.
- Avoid Obstructions. • Stay away from trees, buildings, machinery and reflective surfaces that can interfere with measurements.

3. Proximity to Control Points

- Prefer locations near known control or benchmark points for easier orientation.
- Ensure Safety and Accessibility.
- The area should be safe for equipment setup and easily accessible for the survey team.

4. **Consider Environmental Factors**
   - Avoid areas with strong winds, poor lighting or wet/slippery surfaces that may affect data accuracy.

5. **Coordinate with Site Engineers**
   - Finalize the location in consultation with project or site engineers to align with the layout plan and work schedule.

Fig. 4. College Ground

3.2 Pre-Field Work Preparation

Pre-field preparation is a crucial step before starting any building layout using a Total Station. It involves thoroughly studying the architectural and structural drawings to identify key points such as grid intersections, column centers and wall corners. These points are then converted into coordinates, either using a local or real-world coordinate system, depending on the project requirements. Control points are planned around the site where the Total Station can be conveniently set up. The coordinate data is organized and formatted for uploading into the Total Station.

Necessary equipment like tripods, prisms, pegs and data controllers are also prepared in advance. The site is inspected to identify any obstructions or uneven ground that may affect measurements. Proper pre-field planning ensures efficient and accurate layout work on-site.

3.2.1 Study Auditorium Building Layout

1. Project Overview

• **Project Title:** Auditorium Building - Ground Floor Plan

The proposed plan for Auditorium Building comprises the ground floor layout designed for a single-storey building with an average floor height of 3.3 meters. The plan includes structural and architectural detailing suitable for public or administrative use, as indicated by the name "Auditorium Building ".

The plan illustrates the architectural layout of an auditorium building. It includes an auditorium hall, stage, green rooms, toilet blocks, office and meeting rooms, conference area and circulation spaces for smooth movement and accessibility.

2. Functional Zones

A. Auditorium Hall

• Size: 17.100 m x 13.665 m
• Capacity: 244 fixed seats arranged in organized rows facing the stage.
• This central space serves as the main venue for performances, lectures, or events.

B. Stage
• Size: 10.480 m x 4.150 m
• Positioned centrally in front of the auditorium, facilitating clear visibility for all audience members.
• Direct access to green rooms on both sides for performers.

C. Green Rooms
• Separate green rooms for male and female performers:
• Gents: 3.080 m x 2.490 m
• Ladies: 3.080 m x 2.490 m
• Both rooms are equipped with attached toilets (1.450 m x 1.200 m) to ensure backstage convenience.

D. Toilet Blocks
• Located on the upper corners of the layout:
• Gents Toilet: 5.345 m x 3.830 m
• Ladies Toilet: 5.345 m x 3.830 m
• Multiple WC cubicles and urinals (gents) with washbasin areas.
• Water cooler space provided outside each block.

3. Administrative Facilities

A. Office Room

• Size: 4.500 m x 6.000 m
• Located on the left side of the entrance passage, suitable for administrative staff or event coordination.

B. Conference Room

• Size: 4.700 m x 5.900 m

• Located on the bottom-left of the plan, designed for private discussions or presentations.

C. Meeting Room

• Size: 4.700 m x 5.300 m

• Located bottom-right, ideal for smaller meetings or planning sessions.

D. Waiting Areas

• Two spacious Waiting areas provided near the lobby and meeting rooms for guests or attendees.

4. **Entrance and Circulation**

A. Entrance Lobby

• Size: 6.230 m x 2.330 m

• A welcoming space that leads directly to the main passage and stage area.

B. Passages

• Central Passage: 2.450 m wide, runs across the width of the stage.

• Side Passages: 1.650 m wide on both sides, connecting to toilets, green rooms and stairway.

C. Staircase:

• Marked as "UP", located at the top-right corner, indicating vertical circulation for upper levels or balcony.

5. Fixtures and Symbols

• **Doors: Types:** D1, D2, D3, and D4 (referenced in the door schedule table on the right).

• **Windows:** Marked as "W" and evenly distributed for natural light and ventilation.

• **Ventilation Shafts:** Indicated as "V", possibly for mechanical ventilation or exhaust systems.

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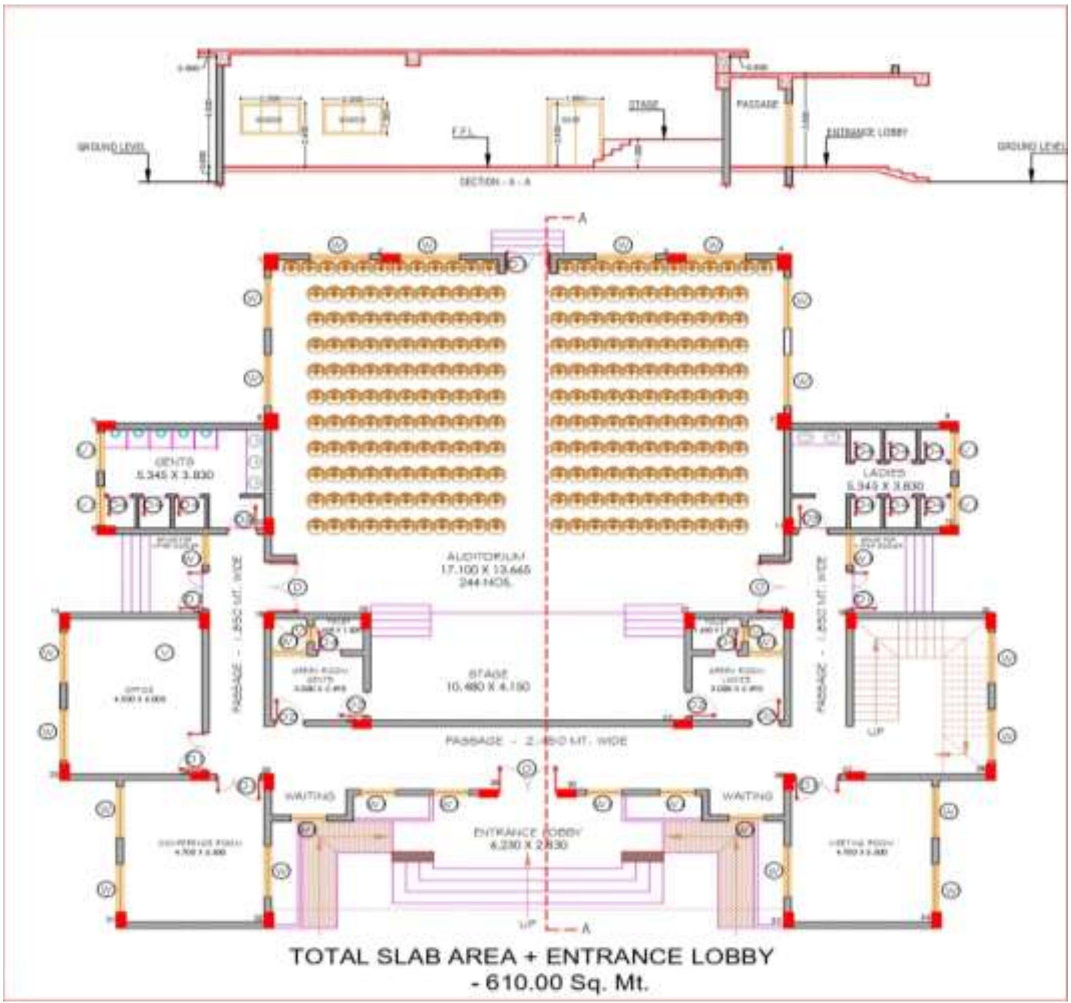

Fig. 5. Auditorium Building Ground Floor Plan

3.2.2. Preparation of Centre Line Plan

The centre line plan is one of the most important drawings prepared before the start of any construction work. It forms the basis for marking on the ground where each structural element such as footings, columns and walls will be located. For the Auditorium Building project, a detailed centre line plan was prepared to ensure precision during layout and construction.

3.2.2.1 Steps Followed in Preparation:

1. Analysing Structural Drawings:

• The structural layout was studied to determine the exact location and number of columns.
• Required grid spacing and structural elements were identified.

2. Creating Gridlines in AutoCAD:

• A horizontal grid (A-P) and a vertical grid (1-8) were developed.
• Intersections of these gridlines indicated column locations.

3. Marking Column Locations:

• Columns were labelled as C1, C2, C3, etc.
• Dimensions between columns were marked on the drawing to assist in field layout.

4. Adding Diagonals:

• Diagonal lines were added to the layout to cross-check and confirm squareness of the plan.

5. Dimensioning:

• All inter-column distances and overall dimensions were clearly marked.
• Units used were in millimetres (mm) for accuracy.

6. Verification and Approval:

• The drawing was checked and verified by the structural consultant. Once approved, the layout plan was handed over to the site team for marking.

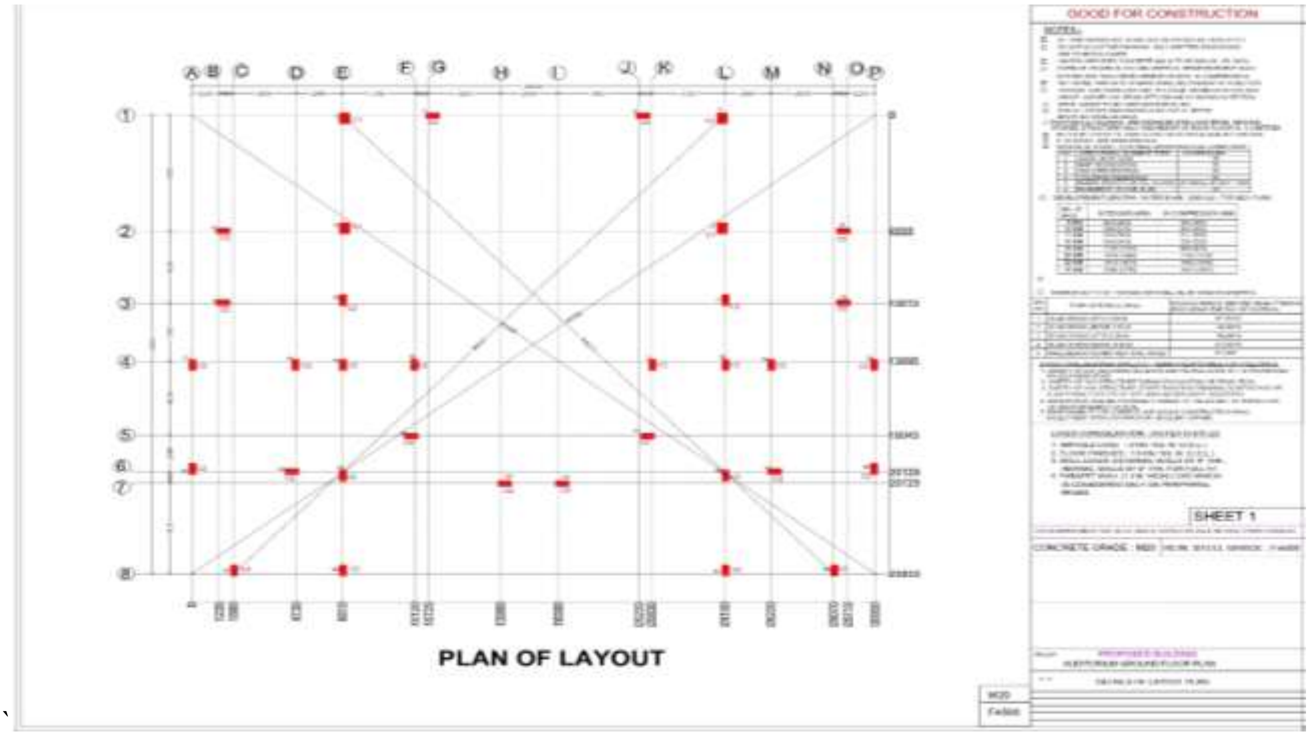

Fig. 6. Auditorium building layout plan

3.2.3 Superimposing Center Line Plan on Architectural Drawing

Superimposing a center line plan on an architectural drawing is a crucial step in the layout process. This process ensures that the structural layout (e.g., column positions, walls, footings) aligns precisely with the architectural design. This combined drawing is then used for field layout using a Total Station.

3.2.3.1. Procedure:

1. Prepare Architectural Drawing

• Prepare auditorium building plan in AutoCAD.
• Open the architectural floor plan in AutoCAD or similar CAD software.
• Ensure units and scale are set correctly (usually in meters or millimeters).
• Clean up unnecessary layers (furniture, hatch, text, etc.) to avoid clutter.

2. Import/Draw Center Line Plan

• Overlay the center lines of columns, walls and other structural components on the architectural drawing.
• Center lines are usually drawn using the LINE command and extended across the structural grid.
• Use different layers (e.g., "Center Line", "Column", "Wall") and color codes for clarity.

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3. Check Alignment

• Use Object Snap (OSNAP) features to align center lines accurately with architectural features like: ✓ Midpoints of walls ✓ Axes of doors/windows ✓ Grid lines
• Verify dimensions to ensure that structural elements (like columns) fit within architectural limits (e.g., between windows, inside walls).

4. Extract Coordinates

• Use the ID or List command in AutoCAD to get coordinates of key layout points (e.g., column intersections).
• Create a CSV or TXT file with point numbers and coordinates (Easting, Northing).
• This file can be uploaded to the Total Station for site marking.

5. Final Output

• Save the combined drawing as DWG/DXF for editing and as PDF for printing.
• Upload the coordinate file into the Total Station for layout.
• Optionally, print the center line plan with architectural references for on-site verification.

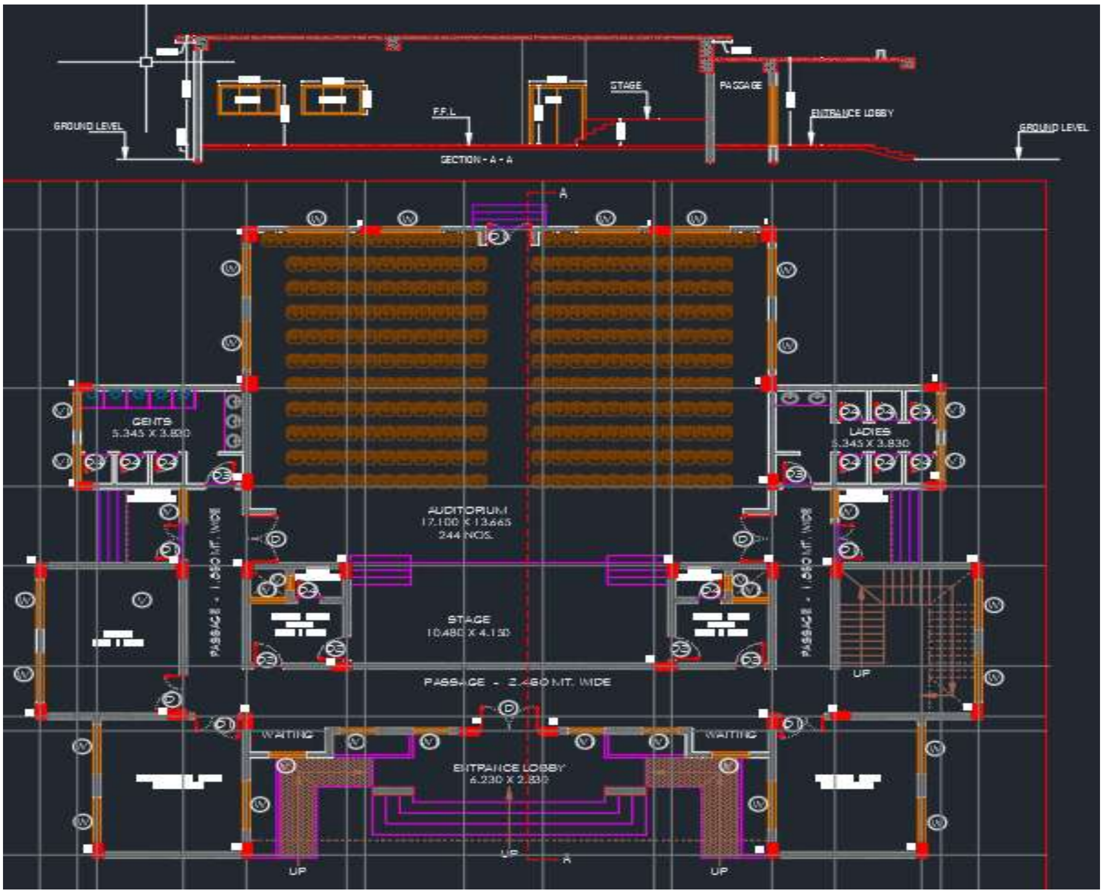

Fig. 7. Superimposed Plan of Auditorium Building

3.3 Field Procedure for Total Station Survey

A total station (TS) is an electric/optic instrument used for surveying, for taking linear and angular measurements with high level of accuracy. It is an electronic or digital transit theodolite integrated with electronic distance measurement (EDM) to measure vertical angles, horizontal angles and slope distance from the instrument to a particular point and an on-board computer to collect data and perform triangulation calculations.

3.3.1 Setting up of Total Station Survey:

1. Levelling the total station (SANDING/ ARC 5 Pro):

Levelling the total station (SANDING/ ARC 5 Pro) must be accomplished to sufficient accuracy otherwise the instrument will not report result. Make sure you can see all the targets from the instrument station before going through the process

1) Tripod setup:

Tripod legs should be equally spaced. Tripod head should be approximately level. Head should be directly over survey point.

2. Mount Instrument on Tripod:

Place instrument on tripod. Secure with centering screw while bracing the instrument with the other hand. Insert battery in instrument before levelling.

3. Focus on Survey point:

Focus the optical plummet on the survey point.

4. Levelling the instrument:

Adjust the levelling foot screws to Centre the survey point in the optical plummet reticle. Centre the bubble in the circular level by adjusting the tripod legs. After retightening the centering screw check to make sure that the plate level bubble is level bubble is level in several directions.

5. Electronically verify levelling

Turn on the instrument by passing and holding the "ON" button. The opening screen will be the "MEAS" screen. Select the [Tilt] function. Adjust the foot. Rotate the instrument 90° and repeat.

6. Adjust image and Reticle focus:

Adjust the reticle (i.e., cross-hair) focus adjustment until reticle image is sharply focused, point telescope to target and adjust the focus ring until target is focused. Move your hand from side to side to test for image shift (parallax). Repeat the reticle focus step if the parallax is significant.

Fig. 8. Total Station (SANDING/ ARC 5 Pro)

3.4 Total Station (SANDING/ ARC 5 Pro) Orientation:

I. Aim:

To find the location or coordinates of the instrumental station using the reflection points.

II. Principle:

Using the given reference, points A and B, the position coordinate of the instrument stations is located.

III. Procedure:

I. With the help of two reference points, the instrument station's coordinate points are found.

II. For which initially, the instrument was placed at a point 'o' and the 2 points which are marked by Pole (A) and Tree (B) are sighted. Then prism reflectors is placed on point A and B with stand.

Fig. 9. Reference point "A" (Pole)

Fig. 10. Reference point "B" (Tree)

Fig. 11. Distance between Reference Point A and B.

III. The points A and B are sighted from the instrument station 'o' and the distance OA and OB slope and horizontal and vertical angles were measured by the instrument. The instrument station coordinate was assumed to (1000.Northing, 1000 Easting).

IV. Now, we have found the coordinates of the points A and B (known coordinates).

Table No.1 Reference Point A and B

Point No.	Easting	Northing
A(P1)	980.148	1020.961
B(P2)	999.918	1034.823

V. Now the instrument must be shifted to another station. The instrument is mounted on point 'S' Now, do the levelling, centering is not required as it's just a random point.

VI. Now, Select Measure "F3"-Resection. Enter the name of the point (Instrument station as 'S')

VII. Measure the instrument height using tape and input into the device.

VIII. Now enter a point name as A. Meanwhile hold the prism at point 'A' and click Measure.

IX. Likewise do for another point say B. Two points are enough to locate the instrument station.

X. Finally, select "Result" to the position of the instrument station (new). It also displays the error and orientation correction.

3.5. Layout Process

1. Stakeout Process

A. Selecting Points to Stakeout

- Choose a point (e.g., Column C1) from the list.
- The Total Station (SANDING/ ARC 5 Pro) calculates the direction and distance to that point from the instrument's position.

B. Using Prism for Marking

- Move the prism to follow instructions (e.g., "move left 0.120 m, forward 0.230 m").
- Once you are in the correct position, the instrument beeps or confirms.

- Mark those points with a Wooden Peg and Chalk (Lime).

Fig. 12. Wooden Peg

Fig. 13. Prism

C. Repeating the Process

- Stakeout all grid intersections, corners and critical points.
- Double-check major points with diagonals and coordinates.

2. Marking Grid Lines and Construction Lines

A. After points is marked

- Use chalk lines or strings to join points and mark gridlines.
- Extend these lines to guide excavation, column shuttering, or wall layout.
- Check perpendicularity using Total Station's angle measurement.

Fig. 14. Marking of Grid Lines

3. Verification & Cross-Checking

- Use resection method to verify instrument position.
- Measure diagonal distances to verify squareness of grid.
- Adjust any layout errors before proceeding to excavation or construction.

4. Column Marking

- With the help of coordinate's points, we have marked 34 columns of different sizes on the ground by following the grid lines.
- Different sizes of columns are shown below:

Table No. 2 Column Dimensions

COLUMN DIMENSIONS		
Sr. No.	**No. Of Column**	**Size Of Column (mm)**
1.	C2, C5, C8, C12, C21, C22, C24, C27, C29 & C30	300X600
2.	C10, C11, C13, C14, C15, C16, C17, C19, C20, C25, C26, C31, C32 & C34	600X300
3.	C1, C4, C6 & C7	600X450
4.	C3	300X700
5.	C9	350X600
6.	C18 & C28	650X 300
7.	C23	750X300
8.	C33	600X300

5. **Documentation and Backup**

- Save the layout file and measurement log from the Total Station.

3.6. Conclusion

We prepared a layout plan on the ground using a total station (SANDING/ ARC 5 Pro) for a total area of 610 m^2. Site reconnaissance is conducted and control points are established based on the layout drawings. The vertical grid lines from A to B are “16 Nos” and Horizontal grid lines from 1 to 8 are “8 Nos”. The total station is then set up and leveled on a known 2 control point and oriented by sighting a back-sight. Layout coordinates are uploaded into the total station or a data collector. Using the "stakeout" function, the instrument guides the user to specific design points, which are then marked on the ground with pegs or chalk. Each marked point is verified for accuracy using distances and angles from the control points and finally, all data is documented for records and further work.

4. RESULT

We have successfully plotted layout plan of auditorium building using the Total Station (SANDING/ ARC 5 Pro) stake-out function, each grid intersection and control point were marked on the college play ground with pegs, nails, or chalk (Lime) depending on the surface. Points were double-checked for accuracy by cross-referencing with adjacent positions.

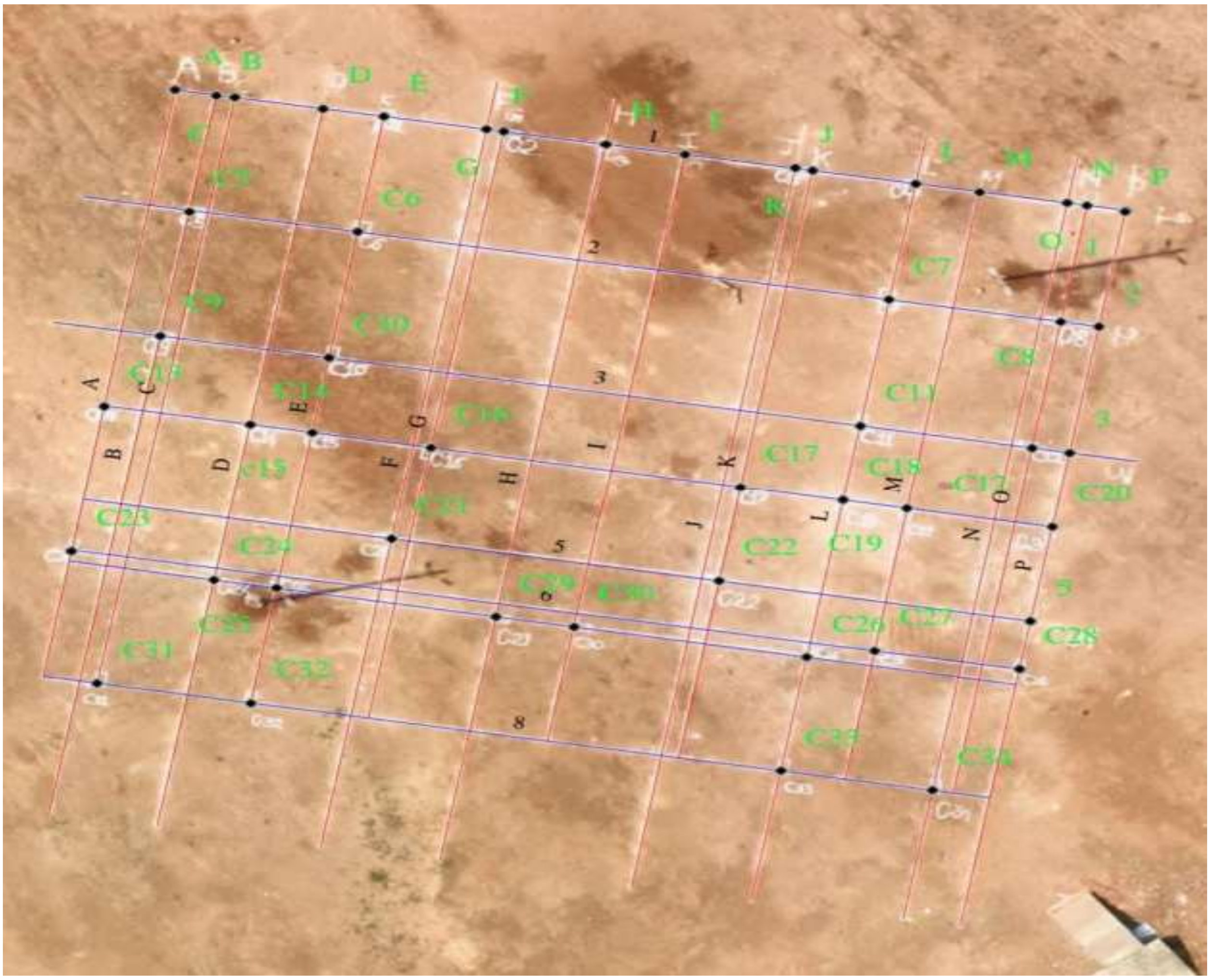

Fig. 15. Layout Plan of Auditorium Building

The above layout plan of 610 m2 area represents a site grid layout used for marking various construction elements with high precision. The grid includes labelled coordinates (A–P horizontally and 1–8 vertically) to organize the site systematically.

The layout is organized in a grid format with column and row markings. It includes all column footings from C1 to C34 labelled in green, which represent column footings center points of structural elements. Columns are marked with black dots at the grid intersections. The use of grid coordinates ensures accurate referencing during the fieldwork. Ensuring angular and linear accuracy for the placement of foundations, columns and walls.

Red vertical lines and blue horizontal lines enhance visual clarity and ensure orthogonal alignment, essential for making layout accuracy. The layout serves as the base reference for transferring design plan on the ground. The Total Station (SANDING/ ARC 5 Pro) helps in reducing human errors by automating measurements and angle calculations. The layout aids in verifying alignment and ensuring symmetry and correct spacing of building elements.