SURVEYOR

NSQF LEVEL - 4

2nd Year

TRADE PRACTICAL

SECTOR : CONSTRUCTION

(As per revised syllabus July 2022 - 1200 Hrs)

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : **Construction**

Duration : **2 Years**

Trade : **Surveyor 2nd Year - Trade Practical - NSQF Level - 4 (Revised 2022)**

Developed & Published by

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First Edition : March 2023 Copies : 500

Rs.200/-

FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Media Development Committee members of various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Surveyor 2nd Year Trade Practical** in **Construction Sector** under **Annual Pattern.** The NSQF Level - 4 (Revised 2022) Trade Practical will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

Director General (Training)
Ministry of Skill Development & Entrepreneurship,
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New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of the Federal Republic of Germany. The prime objective of this institute is to develop and provide instructional materials for various trades as per the prescribed syllabi (NSQF) under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

In order to perform the skills in a productive manner instructional videos are embedded in QR code of the exercise in this instructional material so as to integrate the skill learning with the procedural practical steps given in the exercise. The instructional videos will improve the quality of standard on practical training and will motivate the trainees to focus and perform the skill seamlessly.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisations to bring out this Instructional Material **(Trade Practical)** for the trade of **Surveyor - NSQF Level - 4 (Revised 2022)** under **Construction** Sector for ITIs.

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NIMI records its appreciation for the Data Entry, CAD, DTP operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks the invaluable efforts rendered by all other NIMI staff who have contributed towards the development of this Instructional Material.

NIMI is also grateful to everyone who has directly or indirectly helped in developing this Instructional Material.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intended to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the 2nd Year Course of **Surveyor under Construction Sector.** Trade supplemented and supported by instructions / informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF LEVEL - 4 (Revised 2022) syllabus are covered. The manual is divided in to Twelve modules.

Module 1	-	Tacheometry Survey
Module 2	-	Contour Survey
Module 3	-	Curves
Module 4	-	Total Station
Module 5	-	Cadastral Survey
Module 6	-	AutoCAD
Module 7	-	Concept and Cartographic Projection
Module 8	-	Setting of GIS and GPS
Module 9	-	Hydrographic Survey
Module 10	-	Transmission Line Site survey
Module 11	-	Railway Line Site Survey
Module 12	-	Building Drawing and Estimate

The skill training in the shop floor is planned through a series of practical exercises centered around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual, a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the Course of the **Surveyor** Trade. The contents are sequenced according to the practical exercise contained in NSQF LEVEL - 4 (Revised 2022) syllabus on Trade Practical. Attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indications about the corresponding practical exercises are given in every sheet of this manual.

It will be preferable to teach/learn trade theory connected to each exercise at least one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not for the purpose of self-learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

Sl.No.	Learning Outcome	Exercise No.
1	Performing tachometric survey using tacheometer. (Mapped NOS: IES/N9443)	2.1.66 - 2.1.67
2	Make topography map using level instrument with contours. (Mapped NOS:CON/N0907)	2.2.68 - 2.2.75
3	Concept & set out of curves. (Mapped NOS:IES/N9444)	2.3.76 - 2.3.82
4	Perform survey work using modern survey instruments (Total station) for prepare a map. (Mapped NOS:CON/N0906)	2.4.83 - 2.4.86
5	Concept of cadastral survey & make a site plan. (Mapped NOS: IES/N9445)	2.5.87 - 2.5.88
6	Perform survey work for prepare a topographical map, cadastral map (mouza map), road project (survey camp in a suitable hilly / undulated area). (Mapped NOS: IES/N9446)	2.5.89 - 2.5.91
7	Perform AutoCAD drawing from field survey data. (Mapped NOS:IES/N9447	2.6.92
8	Concept& draw cartographic projection. (Mapped NOS: ES/N9448)	2.7.93 - 2.7.95
9	Plan and prepare setting of GIS & GPS, techniques in various fields. (Mapped NOS:IES/N9449)	2.8.96 - 2.8.100
10	Perform the hydrographic survey (cross section & velocity determination) using the hydrographic survey instruments. (Mapped NOS:IES/N9450)	2.9.101 - 2.9.104
11	Perform transmission line site survey & prepare a site plan. (Mapped NOS:IES/N9451)	2.10.105 - 2.10.110
12	Perform the railway line site survey using modern survey instruments. (Mapped NOS:IES/N9452)	2.11.111 - 2.11.115
13	Draw a double storied building by AutoCAD& prepare a detailed estimate of building.(Mapped NOS:CON/N1302)	2.12.116 - 2.12.117

SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) with Indicative hours	Professional Knowledge (Trade Theory)
Professional Skill 56 Hrs.; Professional Knowledge 12 Hrs.	Performing tachometric survey using tacheometer.(Mapped NOS:IES/N9443)	66. Determination of horizontal and vertical distances by tachometric method. (30hrs.) 67. Determination of stadia constants of a tachometer. (26 hrs.)	Introduction of tachometry & terms use advantages and disadvantages. Tachometric constants & its determination. Determination of horizontal & vertical distances by various methods. (12hrs.)
Professional Skill 112 Hrs.; Professional Knowledge 32 Hrs.	Make topography map using level instrument with contours. (Mapped NOS:CON/N0907)	68. Prepare contour (direct/indirect method) (20hrs.) 69. Interpolation of contour. (15 hrs.) 70. Draw contour lines. (12 hrs.) 71. Locating contour gradients. (10hrs.) 72. Preparation of section from contour map. (15hrs.) 73. Computation of volume (prismoidal / trapezoidal) formula. (10hrs.) 74. Establishment of gradient by abney level. (10hrs.) 75. Make a topography map with contours. (indirect method) 20hrs.)	Contouring, contour interval selection of contour interval, characteristics of contour, uses of contour contouring by various method. Interpolation of contour by various methods, drawing of contours, computation of volume establishment of gradient by abney level. (32hrs.)
Professional Skill 112 Hrs.; Professional Knowledge 32 Hrs.	Concept & set out of curves. (Mapped NOS: IES/N9444)	76. Computation of elements of simple curve. (20 hrs.) 77. Set out of simple curve by linear method. (15 hrs.) 78. Set out of simple curve by instrument method. (17 hrs.) 79. Set out of compound curve by instrument method. (15hrs.) 80. Set out of reverse curve by instrument method. (15hrs.) 81. Set out of transition curve by instrument method. (15hrs.) 82. Set out of vertical curve by instrument method. (15hrs.)	Curves, Purpose, Types of curves – simple, compound, reverse, transition, vertical. Elements of simple curve, computation of elements of simple curve. Various methods for setting out simple, compound, reverse, transition & vertical curve. (32 hrs.)
Professional Skill 112 Hrs.; Professional Knowledge 32 Hrs.	Perform survey work using modern survey instruments (Total station) for prepare a map. (Mapped NOS: CON/N0906)	83. Temporary adjustment of Total station. (20hrs.) 84. Measurement of angle & coordinates and heights. (27hrs.) 85. Traversing using Total station. (40hrs.) 86. Download survey data and Plotting. (25hrs.)	Familiarization with modern survey instruments. Parts of Total station, temporary adjustment of T.S, working procedure of T.S. (32 hrs.)

Professional Skill 28 Hrs.; Professional Knowledge 8 Hrs.	Concept of cadastral survey & make a site plan. (Mapped NOS: IES/N9445)	87. Prepare a site plan by the help of mouza map. (16 hrs.) 88. Calculate the plot area by digital planimeter. (12 hrs.)	Familiarisation with cadastral map, term used in cadastral survey, preliminary knowledge for prepare a site plan. Calculation of area by digital planimeter. (08 hrs.)
Professional Skill 56 Hrs.; Professional Knowledge 16 Hrs.	Perform the site survey using prismatic compass	89. Prepare topographical map (direct & indirect method). (20 hrs.) 90. Make a cadastral/ mouza map & calculate the plot area. (20hrs.) 91. Prepare a detail road project more than 1KM.(16 hrs.)	Details knowledge for preparation of topographical map. Details knowledge for preparation of cadastral map. Details knowledge for preparation of a road project. (16 hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 08 Hrs.	Perform AutoCAD drawing from field survey data. (Mapped NOS: IES/N9447)	92. Survey drawing practice using AutoCAD commands (28 hrs.)	Use auto cad command survey software for survey drawing. (08 hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 08 Hrs.	Concept& draw cartographic projection. (Mapped NOS: IES/N9448)	93. Drawing of Simple conical projection, polyconic, lambert's & UTM (Universal Transverse Mecrcator). (10 hrs.) 94. Construction of UTM Grid. (10 hrs.) 95. Use datum defining system 1984 (WGS-84). (8 hrs.)	Importance of cartographic projection. Uses of various types of cartographic projection for mapping. (8hrs.)
Professional Skill 112 Hrs.; Professional Knowledge 36 Hrs.	Plan and prepare setting of GIS & GPS, techniques in various fields. (Mapped NOS: IES/N9449)	96. Setting of GPS/DGPS. (10 hrs.) 97. Construction of UTM Grid. (10 hrs.) Data collection (measurement of line & calculation of area) (20 hrs.) 98. Data collection in DGPS mode. (15 hrs.) 99. Processing of GPS data in software. (10 hrs.) 100. Plotting the contour lines with the help of Auto Civil/ Civil 3D Software/any other software. (57 hrs.)	Introduction of GIS& GPS. Elements of GPS/DGPS. Observation principles. Sources of error & handling of error in GPS. Various type of GPS application. Concept & use of survey software. (36hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 20 Hrs.	Perform the hydrographic survey (cross section & velocity determination) using the hydrographic survey instruments. (Mapped NOS: IES/N9450)	101. Determine hydrographic depth by (sounding method)/ eco sounder. (10 hrs.) 102. Measure the velocity of flow. (07 hrs.) 103. Determine the cross sectional area of a river. (06 hrs.) 104. Calculate the discharge of a river (5 hrs.)	Introduction to hydrographic survey, practice various method s of water depth measurement process, floe velocity measurement & determination of cross sectional area of a river. Handling of eco sounder, current meter. (20hrs.)

Professional Knowledge 28 Hrs. Professional Skill 16 Hrs.;	Perform transmission line site survey & prepare a site plan. (Mapped NOS: IES/ N9451)	105.Justify constructing a new transmission line. (03hrs.) 106.Marking of tentative alignment on existing topographical map. (04hrs.) 107.Conduct reconnaissance/ preliminary survey & select a good alignment. (6hrs.) 108.Conduct detailed survey, prepare a profile drawing using sag template. (6 hrs.) 109.Conduct final location survey. (6 hrs.) 110.Mark tower foundation pit point (as per type of tower) (03hrs.)	Basic terms used in transmission line survey, justification criteria for constructing new line, marking process of tentative alignment, selection process of a good alignment. Process of detail survey & final location survey. Use of sag template, Various type of tower, construction of tower foundation. (16hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 8 Hrs.	Perform the railway line site survey using modern survey instruments. (Mapped NOS:IES/ N9452)	111.Justify to construct a new Railway line. (03 hrs.) 112.Marking of tentative alignment. (04 hrs.) 113.Conduct reconnaissance/ preliminary survey & select a good alignment. (8 hrs.) 114.Conduct detailed survey, prepare of drawing including design of curves with setting out table. (7hrs.) 115.Conduct final location survey. (6hrs.)	Basic terms used in railway line project survey, justification criteria for constructing new line, marking process of tentative alignment, selection process of a good alignment. Process of detail survey & final location survey. (8hrs.)
Professional Skill 112 Hrs.; Professional Knowledge 32 Hrs.	Draw a double storied building by AutoCAD& prepare a detailed estimate of building. (Mapped NOS: CON/ N1302)	116.Draw a double storied residential building plan, elevation, cross section, site plan, lay out plan, foundation details etc. (78 hrs.) 117.Prepare a detail estimate of this building. (34 hrs.)	Specification & uses of various types of building materials, types of foundation, knowledge of R.C.C. works, & other construction related items. Procedure of prepare a detail estimate. (32hrs.)

Determination of horizontal distance and vertical distances by tacheometric method (Stadia method)

Objectives: At the end of this exercise you shall be able to
- **set up and level tacheometer**
- **take staff readings using tacheometer**
- **compute the horizontal distance.**

Requirements

Tools / Instruments

- Tacheometer - 1 No.
- Levelling staff - 1 No.
- Pegs - 2 Nos.
- Hammer - 1 No.

Materials

- Field book & pen - 1 No each.

PROCEDURE

1 Erect the pegs at the end points of the line whose length is to be determined.

2 Setup and level the tacheometer over point A.

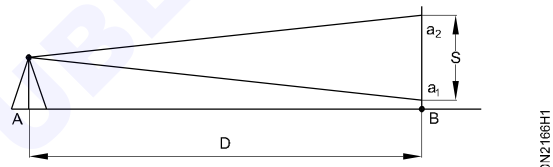
3 Hold the staff vertically at the other point (say B) and then take the stadia readings.

4 Calculate the staff intercept from the observed staff readings.

5 We have D = (f/i)s+(f+d) using this relation compute the horizontal distance.

Given f/i and (f+d)

Fig 1



DETERMINATION OF DISTANCE BY TANGENTIAL METHOD

Determination of horizontal and vertical distance by tangential method

Objectives: At the end of this exercise you shall be able to
- **set up and level theodolite**
- **measure vertical angle**
- **compute horizontal and vertical distance.**

- To determine horizontal and vertical distances between two points A and B.

1 Set up and level the theodolite at point A. (Fig 1)

2 Erect a ranging rod marked with two targets T1 and T2 at a distance of 1m, at B.

3. Measure the vertical angles subtended at station point A with two target points.

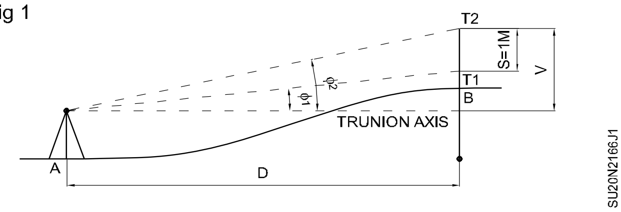
4 Compute the horizontal distance AB using the equation D = S / (tan∅ 1± tan ∅ 2)

- Where S is the target distance 1m.
- ∅ 1 vertical angle made at station A with target point T1.
- ∅ 2 vertical angle made at station A with target point T2.
- Use + sign where one angle is in angle of elevation and other in depression.
- Use - sign when both angles are in either elevation or in depression.

Vertical Distance of T_2 from Trunnion axis.

V = D tan∅ 2

Fig 1



Determination stadia constants of a Tacheometer

Objectives: At the end of this exercise you shall be able to
- **set up and level tacheometer**
- **take staff readings**
- **compute tacheometric constants.**

Requirements

Tools / Instruments

- Tacheometer - 1 No.
- Levelling staff - 1 No.
- Pegs - 4 Nos.
- Hammer - 1 No.

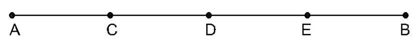
Materials

- Field book, pen - 1 No each.

PROCEDURE

1 On a fairly level and firm ground erect a line AB of length 100 m. (Fig 1)

Fig 1



DETERMINATION OF TACHEOMETRIC CONSTANTS

SU20N2167H1

2 Mark pegs at 25m interval along this line and mark these points as C, D, and E.

3 Set up, centre and level the tacheometer over station point. A.

4 Hold the staff vertically at point C and then take stadia readings.

5 Also take stadia readings at station points D, E and B.

6 Calculate the staff intercepts for various stations from the observed staff readigns, say, S1, S2, S3 and S4.

7 We have $D = (f/i)\ S+(f+d)$

Then

$25 = (f/i)\ S1+(f+d)$........................... equ (1)

$50 = (f/i)\ S2+(f+d)$........................... equ (2)

$75 = (f/i)\ S3+(f+d)$........................... equ (3)

$100 = (f/i)\ S4+(f+d)$........................... equ (4)

8 Solving a pair of equations we can determine the value of the constants. Mean of these values will give the required value of the constants.

Prepare contour (Direct method)

Objectives: At the end of this exercise you shall be able to
- **establish various directions using plane table**
- **locate the contour points**
- **draw the contour lines.**

Requirements

Tools/Equipments/Instruments

- Plane table with tripod, trough compass, alidade
- Dumpy level with tripod
- Ranging rods, levelling staff, tape, pegs, hammer, scale set, drawing instruments

Materials

- Drawing sheet A2 size, field book, pencil & eraser

PROCEDURE

1 Select a suitable point "0" at the centre of the area (Fig 1)

2 Centre and level the plane table over the point.

3 Draw the direction of north on the drawing using trough compass.

4 With alidade pivoting the point '0' draw a number of radial lines.

5 Measure the distance of each of these lines and scale off the distance and mark the end points on respective lines.

6 Set up and level the dumpy level near the centre point.

7 Establish a temporary bench mark near the centre point.

8 Take a BS reading on the bench mark.

9 Also take staff readings at centre point and at the end of each radial line.

10 Calculate the reduced levels of these points.

11 Decide the reduced levels of points that are to be located on each of the radial line.

12 Calculate the staff reading required to locate a particular contour point i.e., staff reading = Height of instrument - reduced level contour.

13 Hold the staff on an estimated position on the radial line and take the staff reading. Move the staff forward or backward till the required staff reading is obtained.

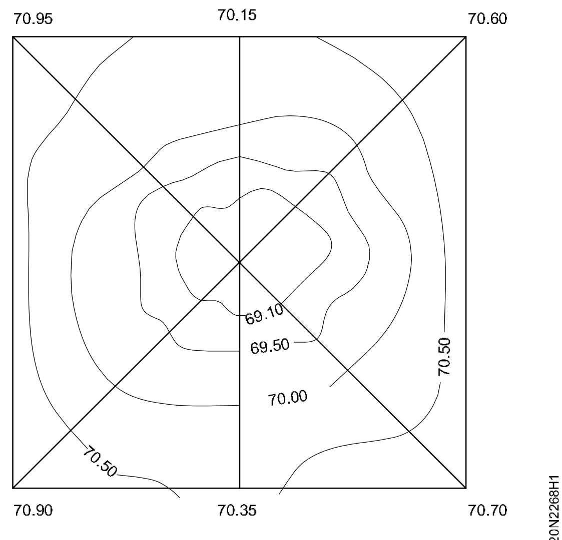
14 Mark the point with a peg and measure the distance of the point from the centre.

15 Similarly mark various contour points on each radial line.

16 Repeat this process on all times.

17 The contour lines are drawn by joining the corresponding points by dotted curved lines.

Fig 1



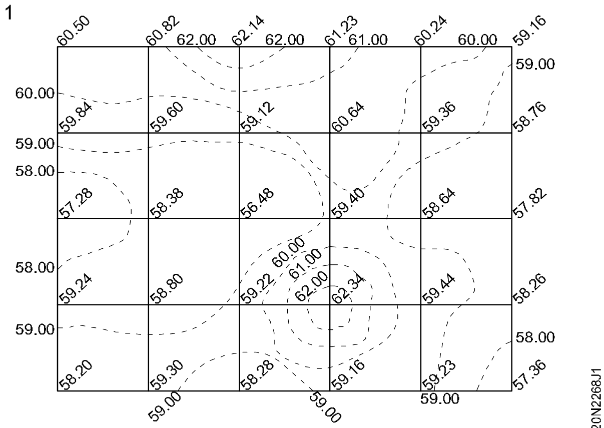
CONTOURS

Indirect contouring by square method

Objectives: At the end of this exercise you shall be able to
- **determine the reduced levels of points**
- **interpolate the contour points**
- **draw the contour lines.**

1 Divide the whole area into a number of squares of side 10m. (Fig 1)

Fig 1



2 Erect pegs at corners of these squares.

3 Establish a temporary bench mark near to the centre of the area.

4 Set up and level the dumpy level at convenient position.

5 Take a BS reading on the bench mark. Also take staff reading on various points on the corner of the squares.

6 Record the staff readings and corresponding distances in a systematic way.

7 Determine the reduced levels of these points by height of collimation method.

8 Select a suitable scale.

9 Plot the squares and write the corresponding reduced levels of corner points.

10 Read and interpret the reduced levels.

11 Decide the contour lines that are to be plotted on the plan from the spot levels.

12 Locate the contour points by arithmetic method of interpolation.

13 Join the points of same R.L with free hand line to get the contour lines.

Indirect contouring by plane table and level

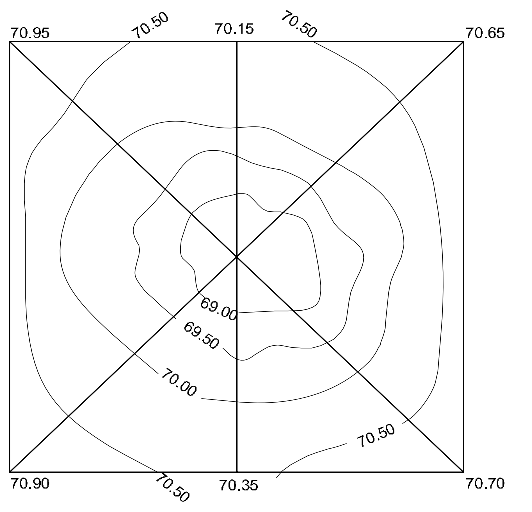
Objectives: At the end of this exercise you shall be able to
- **establish various directions using plane table**
- **determine the reduced level using dumpy level**
- **locate the contour points by interpolation**
- **draw the contour lines.**

1 Follow the steps 1 to 10 of exercise "Prepare contour by Direct method:.

2 Decide the reduced levels of contour points on the radial lines and locate them by interpolation. (Fig 1)

3 Join the points of same elevation with free hand line to get the contour lines.

Fig 1

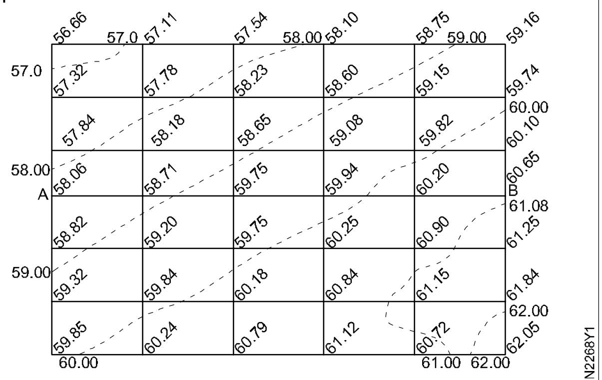


Indirect contouring by cross section2

Objectives: At the end of this exercise you shall be able to
- **determine the reduced levels of points**
- **interpolate the contour points**
- **draw the contour lines.**

1 Mark the centre line of the road with ranging rod. (Fig 1)

Fig 1



INDIRECT CONTOURING BY CROSS-SECTION

2 Divide the centre line into different segment according to direction.

3 Measure the direction of these segments using compass.

4 Measure the length of the line using tape and also mark pegs at an interval of 20m along the centre line.

5 Erect cross section line at the longitudinal section points.

6 Mark points at an interval of 5m along these cross section lines.

7 Establish a bench mark near to the starting point.

8 Set up and level the dumpy level at a convenient position.

9 Take a BS reading on the bench mark. Also take staff reading at various cross section points.

10 Record the staff readings and distances in the respective columns as soon as they are taken.

11 Take FS reading on change point when visibility is being obstructed due to long sight.

12 Continue the work up to the last point and end the work on a bench mark.

13 Compute the reduced levels of the points by height of collimation method.

14 Select a suitable scale.

15 Plot the section and write the corresponding reduced levels of longitudinal as well as cross section points.

16 Read and interpret the reduced levels and decide the contour lines that are to be plotted on the plan from the spot levels.

17 Locate the contour points by arithmetic method of interpolation.

18 Join the points of same elevation by free hand lines to get contour lines.

Interpolation of contour

Objectives: At the end of this exercise you shall be able to
- **determine the reduced level using telescopic alidade**
- **interpolate the contour points**
- **draw the contour lines.**

Requirements

Tools/Equipments/Instruments

- Plane table with tripod
- Telescopic alidade, levelling staff, tape, pegs, hammer, scale set

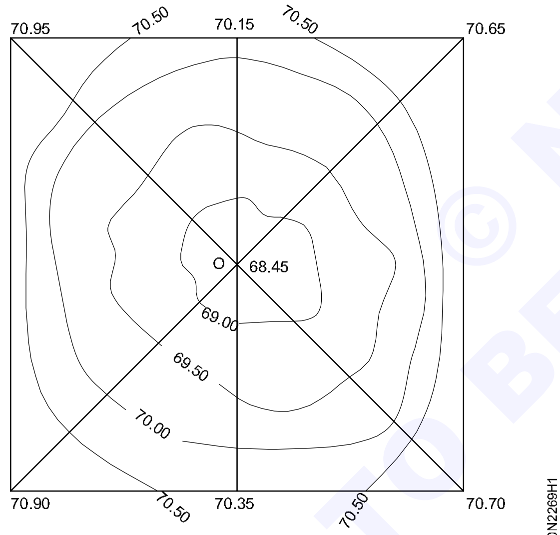
Materials

- Drawing sheet, level field book, pencil & eraser

PROCEDURE

1 Select a suitable point '0' at the centre of the area (Fig 1)

Fig 1



INDIRECT CONTOURING BY RADIAL LINE

2 Centre and level the plane table over the point '0'.

3 Draw the direction of north on the drawing using trough compass.

4 With telescopic alidade pivoting the point '0' draw a line with line of sight horizontal, take staff readings at the end point of this line i.e., top hair reading, central hair reading and bottom hair reading.

5 Similarly draw a number of radial lines and take respective staff readings.

6 Take a BS reading on the bench mark.

7 Also take staff reading on the point '0'.

8 Calculate the distance using the formula D=100S, where D is the horizontal distance between the centre point '0' and the staff station and S is the difference of the top and bottom hair staff reading.

9 Calculate the HI and find the reduced levels of centre point and end points of the radial lines. Reduced level of point = HI-centre hair reading.

10 Decide the reduced levels of contour points on the radial lines and locate them by interpolation.

11 Join the points of same elevation with free hand line to set contour lines.

Drawing of contour lines

Objectives: At the end of this exercise you shall be able to
- **establish various directions using compass**
- **locate the contour points**
- **draw the contour lines.**

Requirements

Tools/Equipments/Instruments

- Prismatic compass with tripod
- Dumpy level with tripod
- Ranging rods, Telescopic levelling staff, tape, pegs, hammer

Materials

- Drawing sheet A2 size, field book, pencil, eraser

PROCEDURE

1 Select a point at the centre of the area. (Fig 1)

2 Set up the compass over the point and carry out the temporary adjustments.

3 Establish a number of radial lines at an angular interval of 60°.

4 Measure the length of these radial lines using tape.

5 Set up and level the dumpy level near the centre point.

6 Establish a temporary bench mark near the centre point.

7 Take a BS reading on the bench mark.

8 Also take staff readings at centre point and at the ends of each radial line.

9 Calculate the reduced levels of these points.

10 Fix the reduced levels of points that are to be located on each radial line.

11 Calculate the staff reading required to locate a particular contour point i.e., staff reading = Height of instrument - reduced level of contour.

12 Hold the staff on an estimated position on the radial line and take the staff reading. Move the staff forward or backward till the required staff reading is obtained.

13 Mark the point with a peg and measure the distance of the point from the centre.

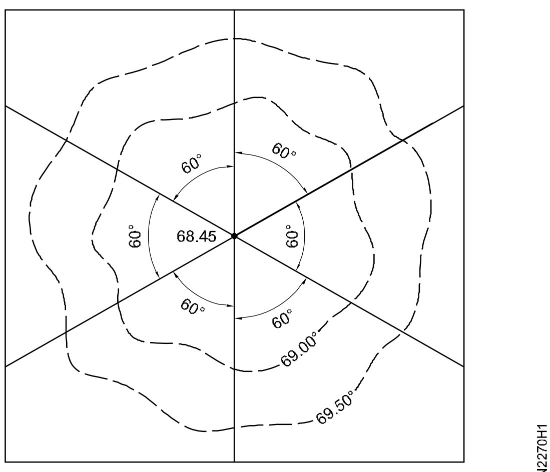
14 Similarly mark various contour points on each radial line.

15 Repeat this process on all time.

16 The points are then plotted on the plan to a suitable scale.

17 The contour lines are drawn by joining the corresponding points by dotted curved lines.

Fig 1



DIRECT CONTOURING BY RADIAL LINE

Locating contour gradient

Objectives: At the end of this exercise you shall be able to
- **locating a contour gradient with an Indian tangent clinometer**
- **locating a contour gradient with a theodolite.**

Requirements

Tools/Instruments
- Indian tangent clinometer
- Theodolite with tripod
- Plumb bob
- Plane table with stand

Materials
- Levelling field book

PROCEDURE

TASK 1: **Locating a contour gradient with an Indian tangent clinometer**

1 Set up the plane table at the point 'A'.

2 Place the clinometer on a plane table, which is centred over the point 'A'.

3 Level the clinometer and the line of sight is clamped on the natural reading for the given gradient.

4 The natural tangents are 0.01,0.005,0.004 respectively.

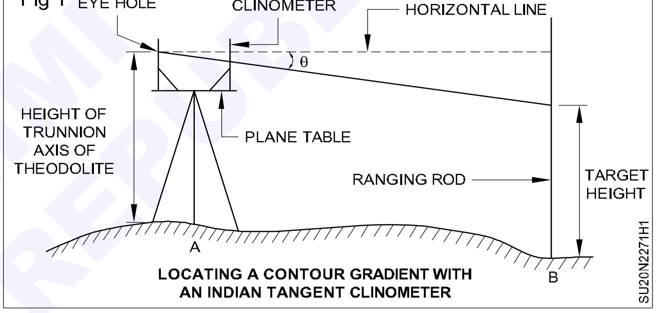
5 Hold the ranging rod by another person with target fixed at the height of the clinometer eye hole.

6 Move up and down the slope, till target is bisected by the line of sight. (Fig 1)

7 Peg the point 'B' on the ground.

8 Shift the instrument to the point 'B', similarly other points C, D etc,.

Fig 1



LOCATING A CONTOUR GRADIENT WITH AN INDIAN TANGENT CLINOMETER

9 Locate the contour point in a similar manner.

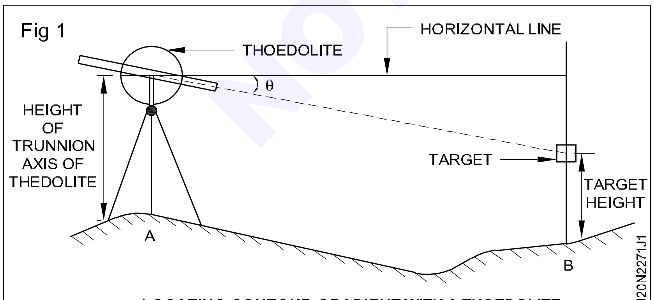
10 The line of sight at points A,B,C,D etc., remain parallel to the lines of joining the points AB,BC,CD, etc,.

— — — — — — — —

TASK 2: **Locating a contour gradient with a theodolite**

1 Set up a theodolite the point 'A' (Fig 1)

Fig 1



LOCATING CONTOUR GRADIENT WITH A THEODOLITE

2 Level and center the theodolite over a starting point (A) of the contour gradient.

3 Telescope points in the required direction of slope.

4 Swing the telescope in the direction of proposed alignment of road.

5 Measure the height (h) of the trunnion axis of the theodolite

6 Fix a target to a rod at the same height is sighted.

7 Bisect the target by the horizontal cross hair of the telescope.

8 The position of the target is the required point on the contour gradient.

9 Shift the instrument to the other point, obtained on the contour gradient.

— — — — — — — —

Preparation of section from contour map

Objectives: At the end of this exercise you shall be able to
- **drawing of section**
- **selection of a cannal alignment**
- **determination of intervisibility.**

Requirements

Materials

- Drawing sheet
- Pencil
- Eraser

PROCEDURE

TASK 1: **Drawing of sections**

1 Draw a section along the line PQ. (Fig 1)

2 Draw X - axis.

3 Plot the point at various contours: which are intersecting line PQ.

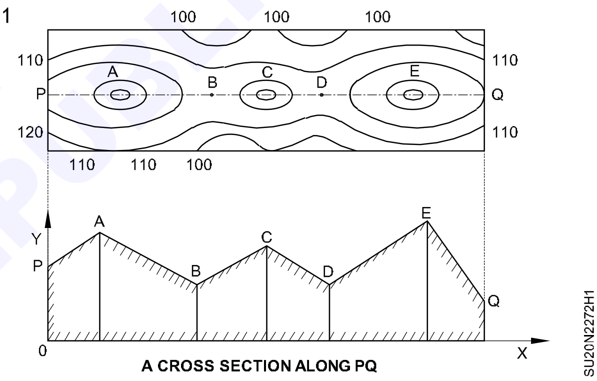
4 Draw Y - axis.

5 Their corresponding height are plotted to a convenient scale.

6 The ends of the perpendiculars representing the contour height.

7 Join the height by smooth straight lines, to give the configuration of the ground surface.

Fig 1



A CROSS SECTION ALONG PQ

— — — — — — — —

TASK 2: **Determination of intervisibility**

1 A and B is given two points.

2 The elevation obtained by interpolations of contours are 635 and 623 meters.

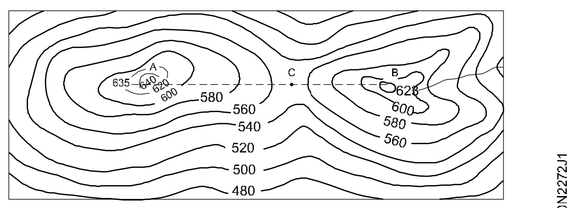
3 Join AB by dotted line with pencil.

4 Contour values decrease up to ‘C’

5 Contour values increase up to point ‘B’

6 No higher value contour appears in between the points A and B are intervisible.

Fig 1



INTERVISIBILITY OF POINTS

— — — — — — — —

Computation of volume (prismoidal/trapezoidal) formula

Objective: At the end of this exercise you shall be able to
• **quantities of earth work by trapezoidal and prismoidal formula.**

Requirements

Materials

- Drawing sheet
- Pencil
- Eraser

PROCEDURE

TASK 1 : **Quantities of earth work by trapezoidal and prismoidal formula**

A railway embankment is 12 m wide. The ground is level in direction transverse to the centre line. Calculate the volume contained in a 120 m length by trapezoidal rule and prismoidal rule, If the direction side slope is 1.5:1. The centre heights at 20 m interval are 3.7 m, 2.6 m, 4.0m, 3.4m, 2.8 m, 3.0 m, 2.2 m.

Solution

For a level section A = (b + sh) h

Slope = 1.5:1, hence s = 1.5

b = 12 m

Let the area at different sections be A_1, A_2,…..

A_1 = (12 + (1.5 x 3.7)) 3.7 = 64.935 m^2

A_2 = (12 + (1.5 x 2.6)) 2.6 = 41.34 m^2

A_3 = (12 + (1.5 x 4.0)) 4.0 = 72.00 m^2

A_4 = (12 + (1.5 x 3.4)) 3.4 = 58.14 m^2

A_5 = (12 + (1.5 x 2.8)) 2.8 = 45.36 m^2

A_6 = (12 + (1.5 x 3.0)) 3.0 = 49.50 m^2

A_7 = (12 + (1.5 x 2.2) 2.2 = 33.66 m^2

Trapezoidal rule

$$V = L\left[\left(\frac{A_1 + A_n}{2}\right) + A_2 + A_3 + ... + A_{n-1}\right]$$

$$= 20\left[\frac{(64.935+33.66)}{2}+41.34+72+58.14+45.36+49.50\right]$$

= 6312.75 m^2

Prismoidal rule

$$V = \frac{L}{3}\left[(A_1 + A_7) + 4(A_2 + A_4 + A_6) + 2(A_3 + A_5)\right]$$

$$= \frac{20}{3}\left[(64.935 + 33.66) + 4(41.34 + 58.14 + 49.50) + 2(72.00 + 45.36)\right]$$

= 6194.9 m^3

A road embankment is 8 m wide and 200 m in length, at the formation level with a side slope of 1.5:1. The embankment has a rising gradient of 1 in 100m. the ground in levels at every 50 m along the centre line are as follows:

Distance (m)	0	50	100	150	200
RL (m)	164.5	165.2	166.8	167	167.2

The formation level of zero chain age is 166 m. calculate the volume of earthwork.

Solution

Rising gradient is 1 in 100 m.

Formation level increases by 0.5 m from every 50 m distance.

Distance	0	50	100	150	200
RL (m)	164.5	165.2	166.8	167	167.2
Formation level (m)	166	166.5	167	167.5	168
Depth of filling. h (m)	1.5	1.3	0.2	0.5	0.8

We know that the area of a cross-section is given by

$A = (b + sh)\,h$

Hence,

$A_1 = (8 + 1.5 \times 1.5)\,1.5 = 15.375\ m^2$

$A_2 = (8 + 1.5 \times 1.3)\,1.3 = 12.935\ m^2$

$A_3 = (8 + 1.5 \times 0.2)\,0.2 = 1.66\ m^2$

$A_4 = (8 + 1.5 \times 0.5)\,0.5 = 4.375\ m^2$

$A_5 = (8 + 1.5 \times 0.8)\,0.8 = 7.360\ m^2$

Interval L = 50 m

Trapezoidal rule

$$V = L\left[\left(\frac{A_1 + A_5}{2}\right) + A_2 + A_3 + A_4\right]$$

$$= 50\left[\left(\frac{15.375 + 7.360}{2}\right) + 12.935 + 1.66 + 4.375\right]$$

$= 1516.875\ m^3$

Prismoidal rule

$$V = \frac{L}{3}\ [(A_1 + A_5) + 4(A_2 + A_4) + 2A_3]$$

$$= \frac{50}{3}\ [(15.375 + 7.36) + 4(12.935 + 4.375) + (2 \times 1.66)]$$

$= 1588.25\ m^3$

— — — — — — — —

Establishment of gradient

Objective: At the end of this exercise you shall be able to
- **set out the gradient 1 in 100 (rising) using dumpy level. The gradient is to be established in such a way that the formation level at starting point is 50cm higher than ground level.**

Requirements

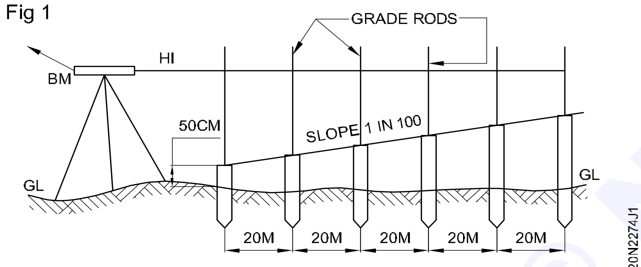
Tools/Equipments/Instruments
- Dumpy level with tripod
- Telescopic levelling staff, tape, peg, hammer
- Measuring tape or chain 30 m

Materials
- Level field book, pencil & eraser

PROCEDURE

1 Mark a horizontal line AB of 100 m long on a level ground. (Fig 1)

Fig 1



ESTABLISHMENT OF GRADIENT

2 Erect pegs at an interval of 20m long this line.

3 Determine the reduced levels of the ground points at the marked point.

4 Compute the formation levels of points with the formation level at starting point (0 chainage) is 50cm higher than the ground level.

Formation level at 20 m chainage = Formation level at ‘0’ chainage + (1/100) x 20

i.e., Formation level at any chainage = Formation level at starting point + (1/100) x chainage.

5 After calculating the formation levels at various chainages, set up and level the instrument at suitable point.

6 Take a BS reading on bench mark and determine the height of the instrument.

7 Calculate the staff readings to establish the points at the required elevations.

i.e., staff reading (grade rod) = Height of Instrument - formation level of the point to be established.

Staff reading at starting point = HI- formation level at ‘0’ chainage.

Similarly calculate the staff readings required to establish all the points.

8 Erect a peg at the starting point.

9 Direct the telescope towards the starting point and observe the staff reading.

10 Compare the observed staff reading with the grade rod calculated at the starting point.

11 Raise or lower the peg erected at starting point get the grade rod at that point.

12 Similarly, erect pegs at all chainage points to establish the required gradient.

Gradient between the two given points

Objective: At the end of this exercise you shall be able to
- **find the gradient between two points.**

1 Mark the points A and B on ground to a given distance. (Fig 1)

2 Calculate the reduced level of each station A and B.

3 Apply usual arithmetical checks to the calculation.

4 Calculate the difference in level between the points A and B = R.L of the Last point - R.L of the first point.

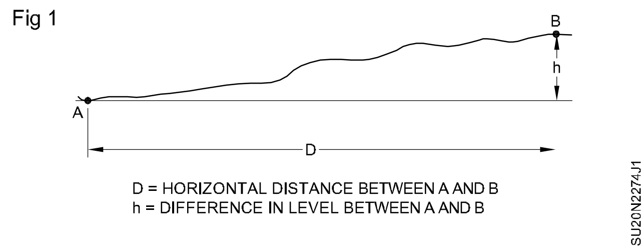


Fig 1

If R.L. of the last point B is more than R.L of the first point A, the gradient is rising gradient.

5 If R.L of the last point B is less than R.L. of first point A, the gradient is falling gradient.

6 Measure the distance between the points A and B by using Tape or chain.

Gradient of the line AB =

$$\frac{\text{Difference in levels between the point A and B}}{\text{Distance between A and B}}$$

Topography map with contour (indirect method)

Objective: At the end of this exercise you shall be able to
• draw the contour lines.

Requirements

Tools/Equipments/Instruments

- Prismatic compass with tripod
- Dumpy level with tripod
- Ranging rods, levelling staff, tape, pegs, hammer

Materials

- Drawing sheet A2 size, level field book, pencil, eraser, scale set

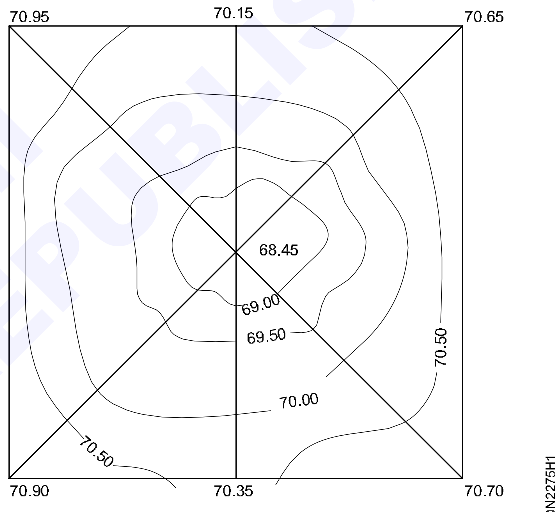
PROCEDURE

1 Follow the steps 1 to 10 exercise no 2.2.70

2 Locate the contour points on the radial line by interpolation. (Fig 1)

3 Join the points of same reduced levels to get the contour lines.

Fig 1



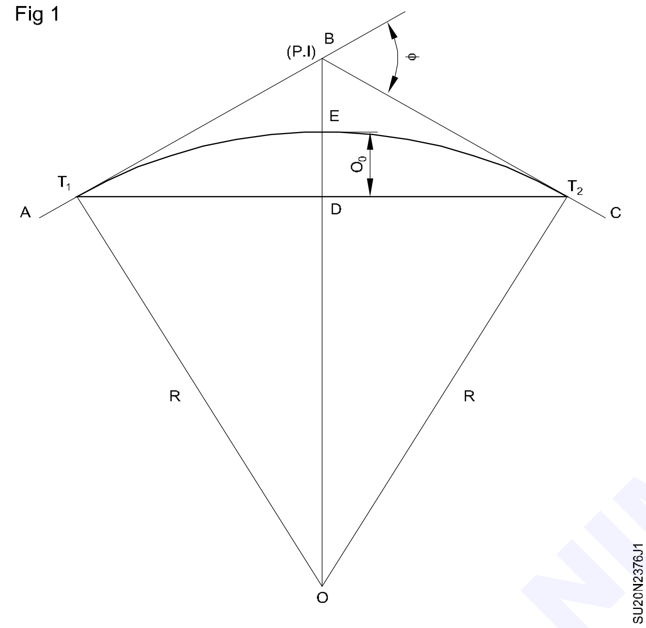
DIRECT CONTOURING BY RADIAL LINE

Computation of elements of simple curve

Objectives: At the end of this exercise you shall be able to
- **determine the element of simple curve**
- **determine the offset from long chord.**

Computation of Elements of Simple Curve. (Fig 1)

Fig 1



Let AB & BC are 2 tangents meeting at a Point B with deflection angle (ϕ)

1 Length of the curve (l)

Lengh, l = T_1ET_2 = R.ϕ, where ϕ is in radians.

$$\therefore l = \frac{\pi R\phi}{180}$$

where R = radius of curve.

2 Tangent length (T) = $T_1B = BT_2$

$$= R.\tan\left(\frac{\phi}{2}\right)$$

3 Length of the long chord (L)

$L = T_1T_2$

$$= 2.R.Sin\left(\frac{\phi}{2}\right)$$

4 Apex distance (or) External distance (E)

Apex distance E = BE

= BO - EO

$$= R.Sec\left(\frac{\phi}{2}\right) - R$$

$$= R\left(Sec\left(\frac{\phi}{2}\right) - 1\right)$$

5 Mid-ordinate (M) - The midordinate O_0 is calculated as follows

a) M = O_0 = ED = EO - DO.

$$M = R - R.Cos\left(\frac{\phi}{2}\right)$$

$$M = R\left(1 - Cos\left(\frac{\phi}{2}\right)\right)$$

b) Again OE = R & OD = R-O_0

ΔOT_1D; $OT_1^2 = OD^2 + T_1D^2$

$$R^2 = (R - O_0)^2 + \left(\frac{L}{2}\right)^2$$

$$\therefore M = O_0 = R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$$

Setting out of simple curve by linear method

Objectives: At the end of this exercise you shall be able to
- **determine the element of simple curve**
- **determine the offset from long chord**
- **set out a simple curve by offsets from long chord.**

Requirements

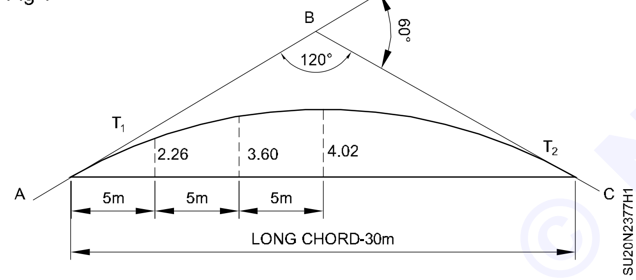
Tools/Equipments/Instruments
- Prismatic compass with tripod
- Ranging rods, chain, tape, pegs, hammer

Materials
- Drawing sheets A2 size Field book, pencil, eraser
- Working plan (For fixing vertex)

PROCEDURE

Set out a simple curve of radius 30m, connecting two directions intersecting at an angle 120° (Fig 1)

Fig 1



R = 30m = 180° - 120° = 60°

1 Compute the elements of the curve

Tangent length = R tan (θ/2)

BT1 = BT2 = 30 tan (60/2) = 17.32 m

Length of long chord (T_1T_2) = 2 R Sin (θ/2 =2x30x sin 60/2 = 30 m

Mid offset or sine of curve (O_0) =

$R - \sqrt{(R^2 - (L/2)^2} = 30 - \sqrt{30^2 - 15^2}$

= 30 - 25.98 = 4.02 m

2 Calculate the offsets from long chord

Ox = $\sqrt{(R^2 - X^2)} - (R - O_0)$

$O_5 = \sqrt{(30^2 - 5^2)} - (30 - 4.02) = 29.58 - 25.98 = 3.60m$

$O_{10} = \sqrt{(30^2 - 10^2)} - (30 - 4.02) = 28.24 - 25.98 = 2.26 m$

$O_{15} = \sqrt{(30^2 - 15^2)} - (30 - 4.02) = 25.98 - 25.98 = 0 m$

3 From vertex (B) fix tangent direction using prismatic compass

4 Measure the length of the tangents from the vertex (B) and mark the points T_1 and T_2 on the tangents.

5 Join the points T1 and T2, which gives the long chord.

6 Mark the midpoint of T1 T2 with a peg. Also erect pegs at an interval of 5m on either side of the midpoint.

7 Erect perpendicular lines at pegs and measure the respective offsets at these points.

8 Join the end points of offsets to get the curve.

Setting out simple curve by (two theodolites) instrument method

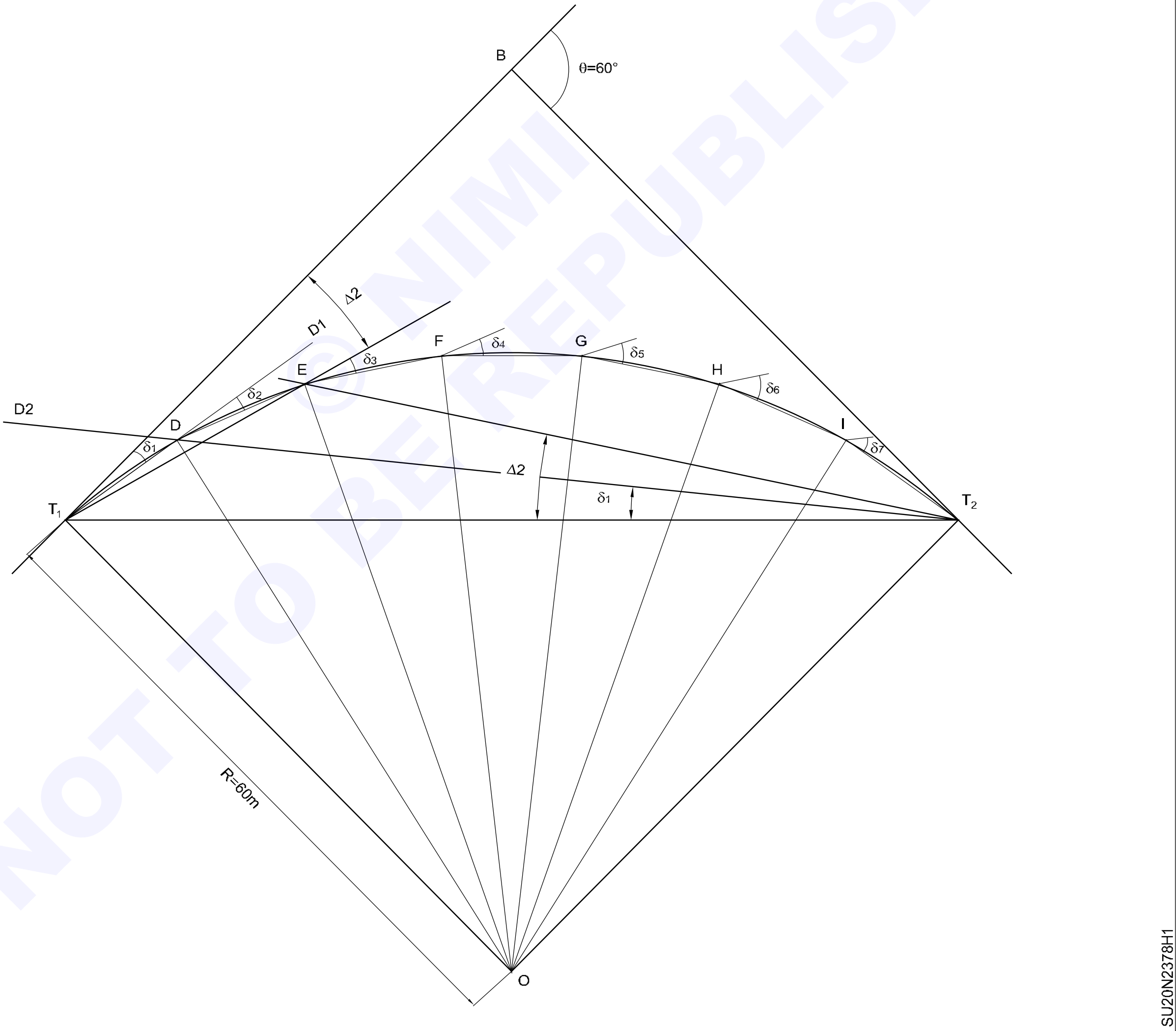
Objectives: At the end of this exercise you shall be able to
- **compute the elements of curve**
- **compute the deflection angles for the curve**
- **set out the curve using the theodolite.**

Requirements

Tools / Instruments		Materials
• Theodolite with tripod	- 2 Nos	• Field book, pencil, eraser
• Ranging rods, pegs, hammer		

TASK 1: **Set out a simple curve of radius 60m, connecting two directions AB and BC intersecting at an angle 120°. (Fig 1)**

Fig 1



1 Compute the elements of the curve.

R = 60m, =deflection angle,θ=180° - 120° = 60°

Tangent length = BT_1= BT_2= R tanθ = 60 tan 60/2 = 34.64m.

Length of long chord (T_1T_2) = 2 R Sinθ/2 = Rx60xSin (60/2)=60m

$$\text{Arclength} = \frac{\pi R\theta}{180} = \frac{\pi \times 60 \times 60}{180} = 62.83\text{m}$$

Take full length of normal chord or peg interval as 9m and first sub chord = 8.83m

Tangential angle for chord = [(C/2R) x (180π)]°

Tangential angle for first sub chord δ_1 = [(C1/2R) x (180/π)]°

$$= \frac{8.83X180}{2X60\pi}$$

δ_1 = 4° 12' 57.65" i.e 4°13'

Tangential angle for normal chord $\delta_2=\delta_3=\delta_4=\delta_5=\delta_6=\delta_7$

$$= \frac{9X180}{2X60\pi} = 4°1749.86"$$

Deflection angle for first chord=$\Delta_1=\delta_1$ =4°12'57.65"=4°13'

Deflection angle for second chord

Δ_2 = Deflection angle for first chord + tangential angle of second = 4°12'57.65" + 4°17'49.86" = 8°30'47.51' = 8°30'40"

Deflection angle for third chord

$\Delta_2 = \Delta_2+\delta_3$ =8°30'47.51" + 4°17'49.86" = 12°48'37.37" = 12°48'40"

Deflection angle for fourth chord

$\Delta_4 = \Delta_3+\delta_4$ = 12°48'37.37"+ 4°17'49.86" = 17°6'27.23" = 17°6'20"

Similarly total deflection angle for fifth chord

$\Delta_5 = \Delta_4+\delta_5$= 17°6'27.23" + 4°17'49.86" = 21°24'17.09" = 21°24'20"

Similarly total deflection angle for sixth chord

$\Delta_6 = \Delta_5+\delta_5$ = 21°24'17.09" + 4°17'49.86" = 25°42'0"

Similarly total deflection angle for seventh chord

$\Delta_7 = \Delta_6+\delta_7$ = 25°42'6.09" + 4°17'49.86" = 29°59'56.81" = 30°

2 Measure the length of tangents from the vertex (B) and mark the tangent points T1 and T2 on the tangents.

3 Set up and level one theodolite at point T_1 and other at T_2.

4 Set the A vernier of both theodolite to read 0°.

5 Release the lower clamp of the theodolite at point T_1 and turn the telescope of theodolite to sight the vertex point B and bisect the point correctly using lower tangent screw.

6 Similarly release the lower clamp of theodolite at point T2 and turn the telescope of the theodolite to sight point T_1 and bisect it exactly using lower clamp and corresponding tangent.

7 Set the A vernier of both theodolites to read the deflection angle of first sub chord i.e., 4° 13'.

8 Now the line of sight of the theodolite at T_1 is along T_1 D_1 and that at T_2 is along T_2 D_2.

9 Locate the intersection point of T_1 D_1 and T_2 D_2 and mark the point D on the curve.

10 Set the A vernier of both theodolites to read the total deflection angle of the second chord and locate the intersection point of the two lines of sight and mark the point E on the curve.

11 Similarly continue the process to locate the points F, G, H and I on the curve.

12 Connect these points to get the curve.

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Setting out of compound curve by instrument method

Objectives: At the end of this exercise you shall be able to
- **identify elements regarding the curve**
- **set out a compound curve**
- **check on field work.**

Requirements

Tools/Equipments/Instruments
- Theodolite with tripod stand
- Ranging rods
- Tape

Materials
- Field book
- Pencil, Eraser.

TASK 1: **Before starting setting out compound curve we should know the following regarding the curve.**

- Δ - Total deflection angle
- Δ_1 - Deflection angle between rear & common tangent - $\angle$IKL
- Δ_2 - Deflection angle between common and forward tangent - $\angle$ILK
- R_S - Radius of small arc T_1O_1
- R_L - Radius of large arc T_2O_2
- T_S - Total tangent length of small arc - T_1I
- T_L - Total tangent length of large arc - T_2I
- KL - Common tangent
- t_1 - The length of the tangent to small arc
  - $R_s\text{-tan}\left(\frac{\Delta_1}{2}\right)$
- t_2 - The length of the tangent to large arc
  - $R_L\text{-tan}\left(\frac{\Delta_2}{2}\right)$
- Angle T_1, O_1, C = 180 - angle T_1 KC = Δ_1
- Angle C O_2, T_2 = 180° - angle CLT_2 = $\Delta 2$

- Then locate the point of intersection I. The point of commencement T_1 and the point of tangency T_2.
- Calculate the chainage of point of commencement (ie) chainage of T_1 = Chainage of I - Tangent length of T_1I
- Calculate the chainage of point of common curvature are (ie) chainage of C = Chainage of T_1 + Length of arc

Length of arc $T_1C = \frac{\pi . R_S . \Delta_1}{180}$

- Calculate the chainage point of tangency (ie) chainage of T2 = Change of 'C' + Length of arc 'T2C'

Length of arc $T_2C = \frac{\pi . R_L . \Delta_2}{180}$

- Calculate deflection angle for both the arcs from their tangents (ie)

$$\delta = \frac{1718.9C}{R}$$

Where: C is chord length

R = Radius of arc

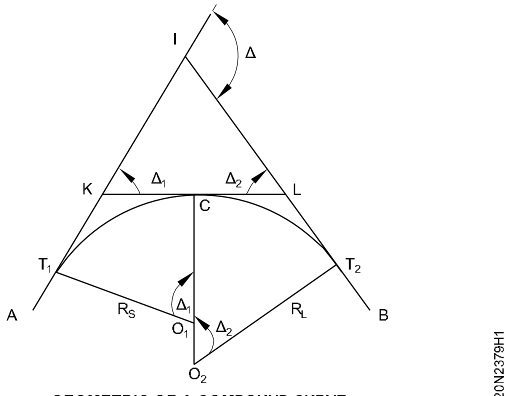
— — — — — — — —

TASK 2: **Set out a compound curve (Field work)**

- Set up the theodolite at the commencement point T_1. (Fig 1)
- Set out the arc T1C explained in simple curve (Ex. 2.3.77)
- Shift the theodolite and set up at point 'C'
- Set the vernier 'A' (360° - Δ1/2) or Δ1/2 according as the curve is right side or left side.
- Take backsight on the point T_1 and transit the telescope
- Produced the line of sight along the line T_1C

- Swing the telescope in clockwise direction through $\Delta 1/2$
- The telescope directs along KCL
- The vernier at A is zero
- Set the vernier to read the first deflection angle of the second arc CT_2 for its first sub-chord.
- Continue this process till the point of tangency T_2 is located.

Fig 1



GEOMETRIC OF A COMPOUND CURVE

— — — — — — — —

TASK 3: **Check on field work**

Check 1:

The point of tangency located from the point of common curvature should coincide with location already fixed by measuring the distance, the distance equal to the total tangent length from the point of intersection.

Check 2:

$$= 180° - \text{Angle } T_1CT_2 = 180° - \left[\frac{\Delta 1}{2} + \right.$$

$$= 180° - \left(\frac{\Delta_1 + \Delta_2}{2}\right)$$

$$= 180° - \frac{\Delta}{2}$$

— — — — — — — —

Set out of reverse curve by instrument method

Objectives: At the end of this exercise you shall be able to
- **establish elements of a reverse curve**
- **state construction of reverse curve.**

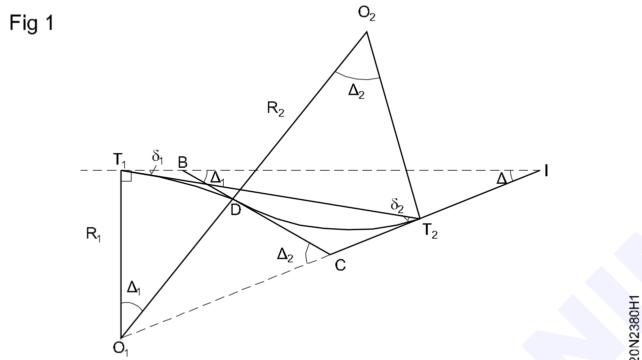
Requirements

Tools/Equipments/Instruments
- Theodolite with tripod
- Ranging rods
- Tape

Materials
- Drawing sheet A2 size
- Field book
- Pencil & eraser

TASK 1: **Elements of a reverse curve (Fig 1)**

Fig 1



ELEMENTS OF A REVERSE CURVE

1 T_1O_1 and T_1I are two straight line, where T_1 common point.

2 R_1 and R_2 are radius of two circular arcs and equal.

3 Δ = angle of total deflection of the straights.

4 $\Delta 1$ and $\Delta 2$ are equal deflection angles of common tangents.

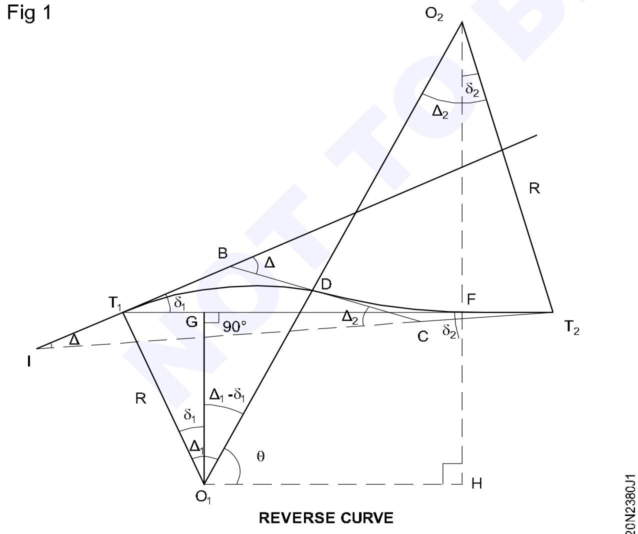
5 δ_1 & δ_2 are angles between the straight and the line joining the points of commencement and tangency respectively.

6 The length of line obtained by joining the tangent points.

— — — — — — — —

TASK 2: **Construction of reverse curve (Fig 1)**

Fig 1



REVERSE CURVE
NON-PARALLEL STRAIGHTS $\Delta_1 > \Delta_2$

Case 1: When two straight lines are non parallel and $\Delta 1 > \Delta 2$ are variable.

Point of intersection: Can be obtained by producing the forward straight backward to intersect the back - straight.

Data given

Length of the line joining the tangent points T_1 and T_2.

Angle δ_1 between T_1T_2 and back straight T_1B

Angle δ_2 between T_1T_2 and forward straight CT_2

Now find common radius R.

Specified condition: $R_1 = R_2 = R$

Let T_1 & T_2 be two tangent points. O_1 & O_2 centres of circular arcs. Distance $T_1 T_2$ be equal to L.

Construction

Draw O_1G & O_2F perpendicular to T_1 T_2 and O_1H perpendicular to O_2F produced.

Assume angle O_2O_1H be θ

Let $T_1T_2 = L = T_1G + GF + FT_2$. ______ (1)

$O_1G = R \cos \delta_1 = FH$

$O_2 F = R \cos \delta_2$

$\therefore O_1O_2 = 2R$.

$$\text{Sin}\theta = \frac{O_2H}{O_1O_2} = \frac{O_2F + FH}{O_1O_2}$$

$$= \frac{R\cos\delta_1 + R\cos\delta 2}{2R}$$

$$= \theta = Sin^{-1}\left(\frac{Cos\delta_1 + Cos\delta_2}{2}\right)$$

now $T_1G = R \sin \delta_1$

$GF = Q_1H = 2R \cos\theta$

$FT_2 = R \text{ Sin } \delta_2$

substitute the value in

$L = R \text{ Sin } \delta_1 + 2R \cos \theta + R\text{Sin } \delta_2$

$$R = \frac{L}{\text{Sin }\delta_1 + 2\text{ Cos }\theta + \text{Sin }\delta_2}$$

For central angle

i For the 1st arc = $\Delta 1 = \delta 1 + (90° - \theta)$

ii For the 2nd arc = $\Delta 2 = \delta 2 + (90° - \theta)$

— — — — — — — —

$\therefore$

Set out the transition curves by tangential offsets

Objectives: At the end of this exercise you shall be able to
- **set out of transition curve by tangential offsets**
- **field work for setting out a cubic parabola**
- **calculate setting a transition curve by offset method.**

Requirements

Tools/Equipments/Instruments
- Cross staff
- Ranging rod, pegs, hammer, Tape

Materials
- Field book
- Pencil, eraser

PROCEDURE

- Take a convenient length of the transition curve.
  Say, L
- Calculate the amount of the shift $S = \frac{L^2}{24R}$
- For cubic parabola, calculate the total tangent length
  $= (R+S)\ \tan\frac{\Delta}{2} + \frac{L}{2}$
- Locate the point of commencement and tangency by measuring the total length from the point of intersection along their straight.
- Calculate the tangential offset for the transition curve by the formulae.

i Cubic parabolic transition curve $x = \frac{Y^3}{6RL}$

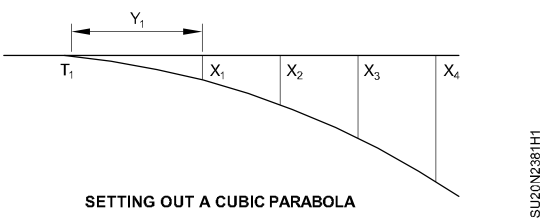
ii Cubic spiral transition curve $x = \frac{l^3}{6RL}$

S.No.	Distance along tangent	Perpendicular offset to the tangent	Remarks
0	0	0	
1	15m	$15^3/6RL$	
2	25m	$25^3/6RL$	
3	35m	$35^3/6RL$	
4	45m	$45^3/6RL$	
5	55m	$55^3/6RL$	

Field work for setting out a cubic parabola

- Select a fairly level ground & fix a total tangent length.
- Measure a distance equal to first peg interval (Y_1) from the point commencement T_1 along the tangent. (Fig 1)

Fig 1

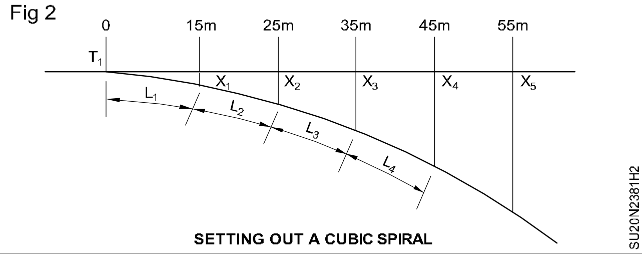


SETTING OUT A CUBIC PARABOLA

- Set out a perpendicular offset (x_1) equal to its calculated value.
- Measure the distance equal to first two peg interval from the point of commencement (T_1).
- Set out the perpendicular offset (x_2) equal to its calculated value.
- Proceed the same method till last offset.
- This locates the junction point of the transition curve with the circular curve.
- Join the ends of the offset and locate to fix the points of a transition curve on the ground.

Setting a transition curve by offset method (Fig 2)

Fig 2



SETTING OUT A CUBIC SPIRAL

Assume Radius = 350m (R)

Length of curve = 150 (L)

$$x = \frac{Y^3}{6RL}$$

Y = 0m $\therefore$ X = 0

$$x_1 = 15m = \frac{15^3}{6x350x150} = \frac{3375}{315000} = 0.01071m$$

$$x_2 = 25m = \frac{25^3}{6x350x150} = 0.049m$$

$$x_3 = 35m = \frac{35^3}{6x350x150} = 0.136m$$

$$x_4 = 45m = \frac{45^3}{6x350x150} = 0.289m$$

$$x_5 = 55m = \frac{55^3}{6x350x150} = 0.528m$$

x_1 = 0.0107 m

x_2 = 0.049 m

x_3 = 0.136 m

x_4 = 0.289 m

x_5 = 0.528 m

So on complete the curve setting to the full tangent length

Setting out a vertical curve and computations

Objectives: At the end of this exercise you shall be able to
- **establish setting out a vertical curve**
- **calculation of constant 'K'.**

Requirements

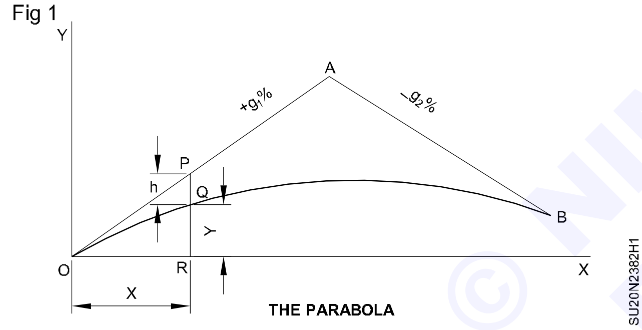
Tools/Equipments/Instruments
- Theodolite with tripod
- Ranging rod
- Tape

Materials
- Drawing sheet A2
- Pencil
- Eraser

TASK 1: **Setting out a vertical curve**

1 OX and OY is the axes of the rectangular ordinates, passing through beginning (o) of the vertical curve (Fig 1)

Fig 1



2 OA = Tangent having + g_1% slope

3 AB = Tangent having - g_2% slope

4 Q = Any point on the curve having co-ordinates (x,y)

5 Draw a vertical line PQR through Q

Then the equation of the parabola $y = ax^2 + bx$ ____(1)

Axis parallel to Y- axis, 'A' is the summit where two gradient meet differentiate. ____(1)

$$\therefore \frac{dy}{dx} = 2ax + b$$

$$if, X = 0, \frac{dy}{dx} = g_1$$

$\therefore g_1 = 2a(0) + b$ (or) $b = g_1$ ____(2)

The equation of the parabola

$y = ax^2 + g_1x$ ____ (3)

h = PQ = Vertical distance between the tangent and the corresponding point 'Q' on the curve = Tangent correction

PQ = PR - QR

But, PR = g_1 x and QR = Y

PQ = h = $g_1x - y$

But $gx - y = -ax^2$ from equation (3)

Hence, $h = g_1x - y = -ax^2$

$\therefore h = Cx^2$ (or) $h = KN^2$

Where C = Constant

K = Constant

N = Distance measured from the beginning of curve.

Note: The elevation difference between the points of vertical curve and a tangent varies as the square of their horizontal distances from the point of tangency. The difference in elevation is the tangent correction.

— — — — — — — —

TASK 2: **Find the value of K (Fig 1)**

Produce OX to Z

Point 'Z' vertically above Y.

Through the point X, draw 'XP' horizontal to meet YZ at P.

Assume 2n = Number of equal chords.

l = each length of chord

Each side of the apex g_1 and g_2 (upgrade and downgrade respectively)

e_1 and e_2 corresponding rises or falls per chord length.

Fig + and - as they represent rise or fall

$OX = ZX$

$ZP = Ne_1$

$PY = -Ne_2$

$YZ = ZP + PY = N(e_1 - e_2)$

From $h = kN^2$

$YZ = KN^2$ (where $N = 2n$)

$K(2n)^2$

$4Kn^2 = n(e_1 - e_2)$

$$K = \frac{e_1 - e_2}{4n}$$

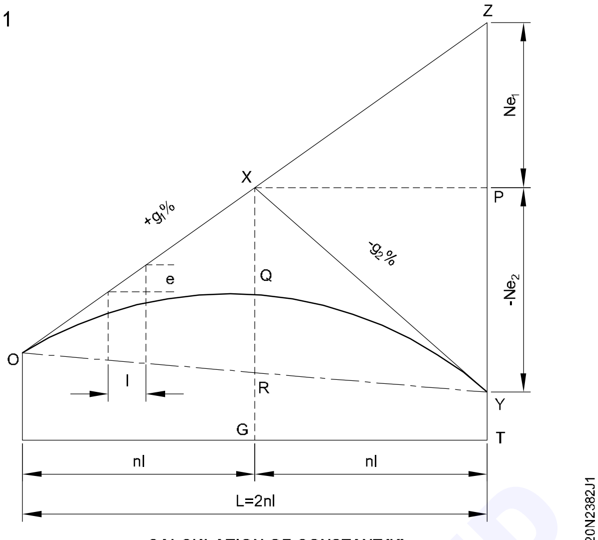


Fig 1 CALCULATION OF CONSTANT 'K'

— — — — — — — —

Temporary adjustment of total station

Objectives: At the end of this exercise you shall be able to
- **unplace and place total station from and to the carrying box respectively**
- **fix and unfix total station to and from the tripod respectively**
- **identify parts of the total station**
- **perform levelling and centering of the total station.**

Requirements

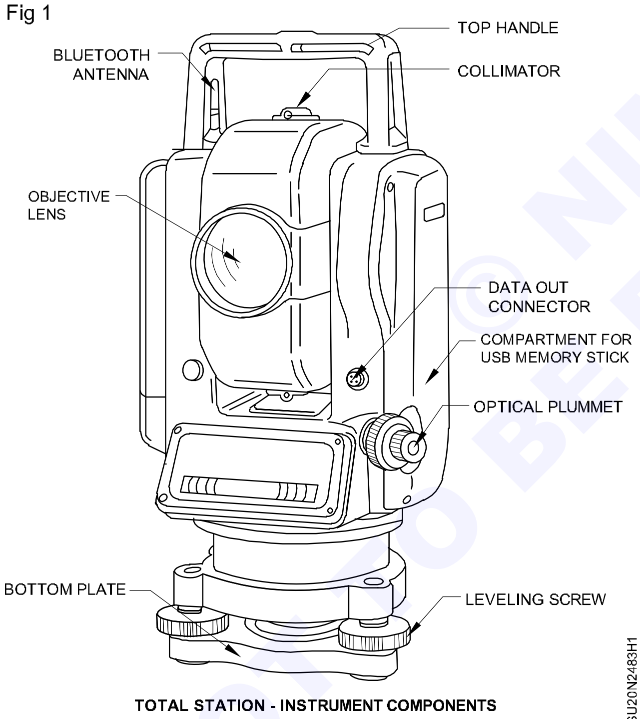
Tools/Equipments/Instruments
- Total station in carrying box with tripod
- Computer with CAD software
- Printer

Materials
- Paper A4 size

PROCEDURE

Set up (Fig 1)

Fig 1



TOTAL STATION - INSTRUMENT COMPONENTS

The following steps are followed for the setup of a total station at a station point.

1 Choose as adequate instrument station. Make sure that an observer can safely operate the instrument without knocking it over. It is necessary to have the center of the instrument, (which is the point of intersection of the transverse axis and the vertical axis of the instrument), directly over a given point on the ground (the instrument station).

2 Remove the plastic cap from the tripod, and leave the instrument case until the tripod is nearly level. Stretch the tripod legs 10-15cm shorter than their maximum length.

3 Open the legs of the tripod to set tripod head at the level of the operator's upper chest. When the total station is set up on the head, the operator's eye should slightly above the eye piece. The instrument height important for an effective and comfortable survey. One should not touch or cling to the tripod during the survey.

4 At the new station with a reference point on the ground, level up the total station at an arbitrary point, where a stake can easily go in and be steady, and put down the stake and centre using the plummet.

5 To occupy an existing station above a reference point, first roughly develop the tripod head right above the point. For levelling up small levels is useful. To find out the position, use a plumb bob or drop a stone through the hole in the tripod head.

6 Once roughly levelled and centered push each tip of the tripod leg firmly into the ground, applying full weight of the observer on the step above the tip. Apply the weight along the tripod leg without bending it.

7 Check the level and centre it again. Adjust the level by changing the leg length.

8 Fix a tribrach with plummet, tribrach and a prism carrier with a plummet or a total station with built-in plummet on the tripod head.

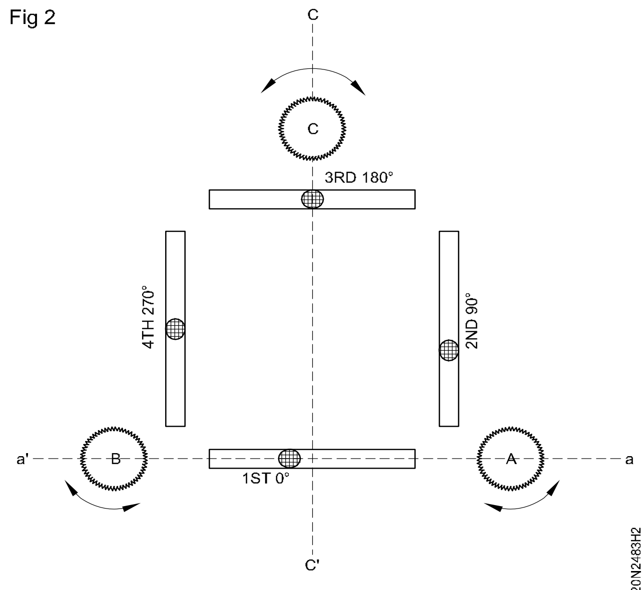
9 Adjust the three screws of the tribrach to centre the bubble in spirit level with the following steps; (Fig 2)

   a Release the lock of the horizontal circle.

   b Rotate the instrument to set the plate level parallel to AB at the 1st position.

   c Turn the foot screws A and B in the opposite direction, in same amount to centre, the plate level. This will adjust till bubble on aa' axis centre.

Fig 2



FINE LEVELLING PROCEDURE

d Turn the instrument 90° to the set the plate level and the 2nd position.

e Turn the foot screw C to the center plate level, adjusting the till bubble along CC'.

f Rotate the instrument 90° to set plate level in the 3rd position.

g Turn the foot screws A and B in the opposite direction, in same amount to eliminate half the centering error.

h Rotate the instrument 90° to the set the plate level at the 4th position.

i Turn the foot screw C to eliminate half the centering error.

j Repeat procedure b to i until the plate level is centered in all directions (give a little time for slow movement of the bubble in viscous fluid).

10 Pull out the optical plummet and use the optic ring to focus and the graticule and then focus the mark on the ground. Or turn on the laser plummet. Rotate the plummet of the total station to check, it is centered within 1cm from the reference point. If not, estimate the amount of offset and carefully translate the entire tripod as much as the offset. Return to procedure 4 and try to level and center again. The total station on the tripod head can be translated 1cm from the center, therefore rough centering within 1cm is necessary. Be careful to see that the center of the optical plummet or the laser point is on an axis perpendicular to the horizontal circle of the total station. If the total station is not level, the plummet line does not coincide with the plumb line.

11 Put the total station over the tribrach if it is not there.

12 Use the plate level for the final levelling of the total station. Follow the instruction given in (Fig 2).

13 When the total station is finely levelled up. Use the plummet of the check centering. If plummet point out the centre of the reference. Slightly loosen the fixing screw below the tripod head and move the tribrach to place the plummet center on the exact point. Do not rotate. When the centering is done, tighten the fixing screw moderately. If any portion of the base of the tribrach goes outside the tripod head, return to 4.

14 Rotate the total station by 180° if the plummet center goes away from the point, slightly loosen the fixing screw and slide the total station halfway to the center.

15 Repeat the steps 12 and 13 until the plummet center stays exactly on the center of the mark.

16 Tighten the fixing screw firmly without applying too much pressure. Never loosen the screw until all the measurements are finished.

17 Measure the instrument height.The centre of the total station is marked on the side of the instrument. The vertical distance between the mark and the ground is the instrument height.

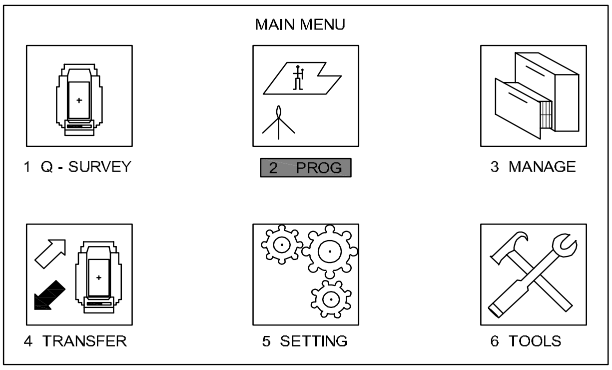
18 Check the plate level from time to time during measurement before the total station tilts beyond the automatic correction.

Station setup for a total station

Objectives: At the end of this exercise you shall be able to
- **give the necessary inputs to the total station**
- **collect the data from the field after station setup.**

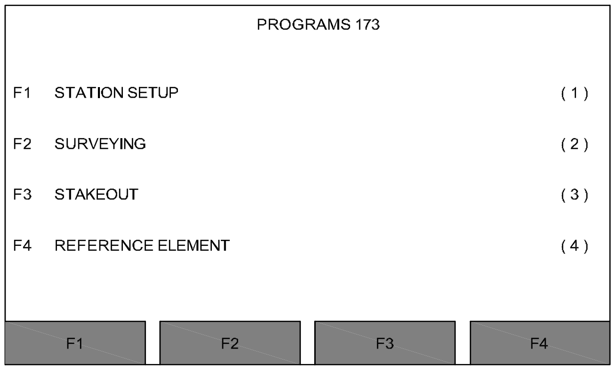
- After centering and levelling (done in previous Exercise) Press MENU
- Switch on the instrument.
- Press (**Programs**) (Fig 1)
- Press F1 (Station setup) (Fig 2)
- Press FNC key Laser Beam for centering and levelling. (Fig 3)
- FNC F1 for levelling & Plummet. (Fig 4)
- Do the levelling centering with help of foot screw & Tripod legs. (Fig 5)
- Press F1 (Set Job) (Fig 6)
- Press F1 (NEW) to give a new job name. (Fig 7)
- To write the name of the job. Press F3 (INPUT) and then using Keyboard give the name and then Press Enter Key. (Fig 8)
- Press F4 (OK) (Fig 9)

Fig 1



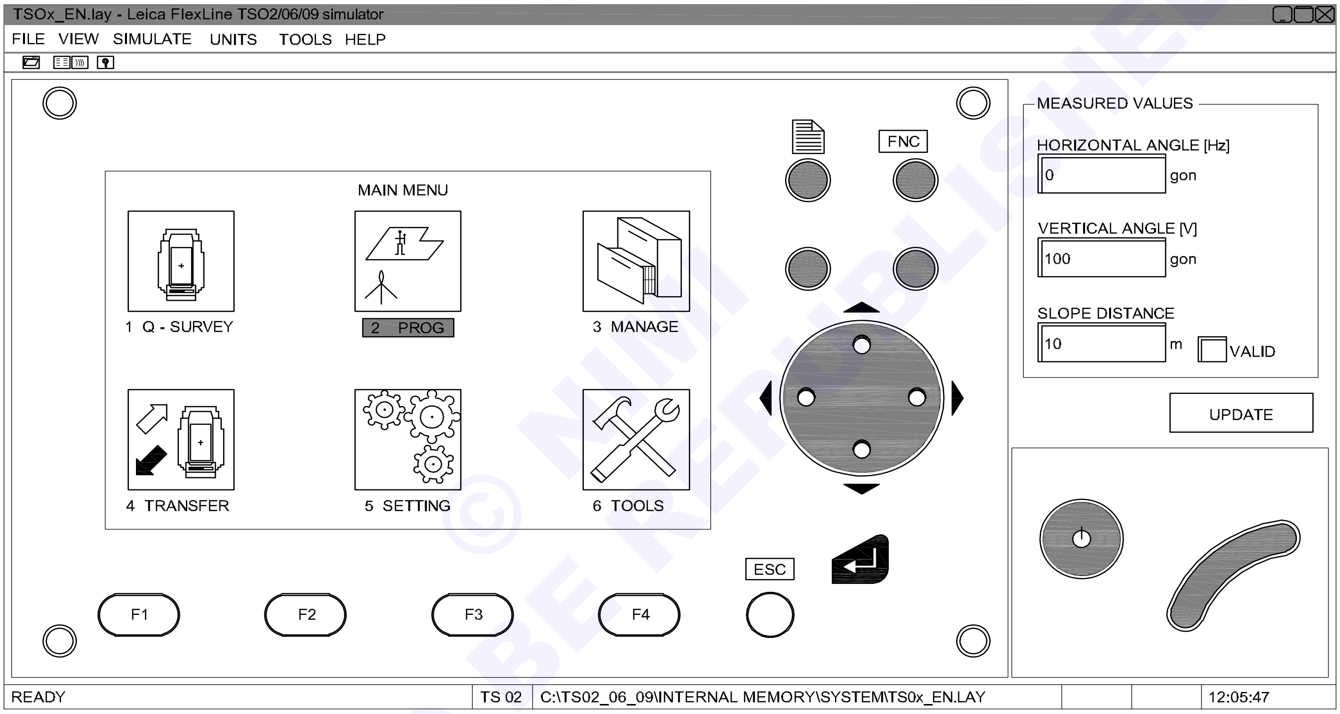
LEVELLING & CENTERING

Fig 2



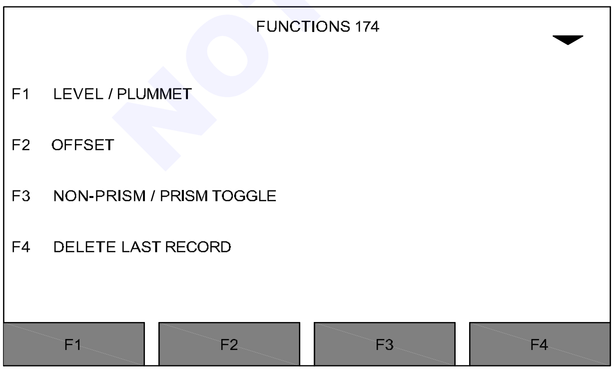
LEVELLING & CENTERING

Fig 3



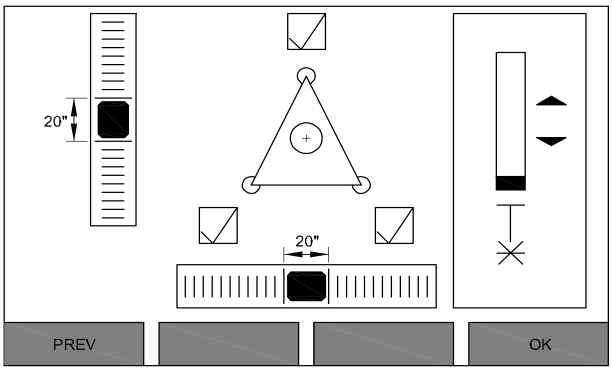
LEVELLING & CENTERING

Fig 4



LEVELLING & CENTERING

Fig 5



LEVELLING & CENTERING

Fig 6

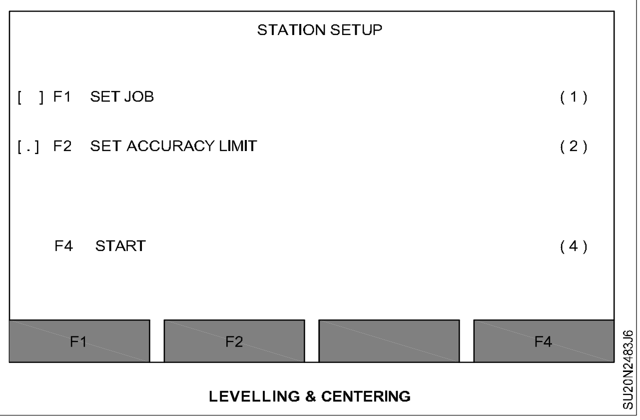


Fig 7

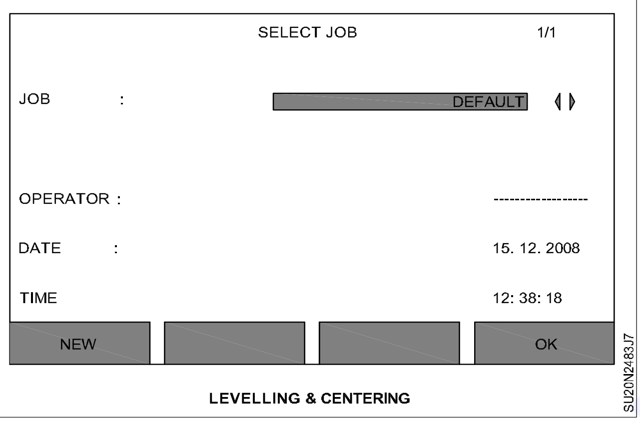


Fig 8

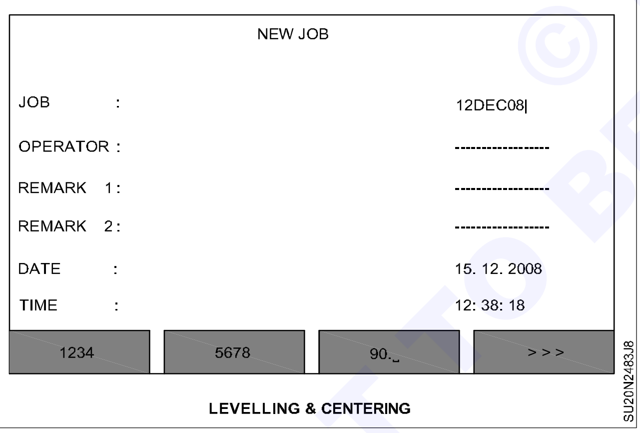
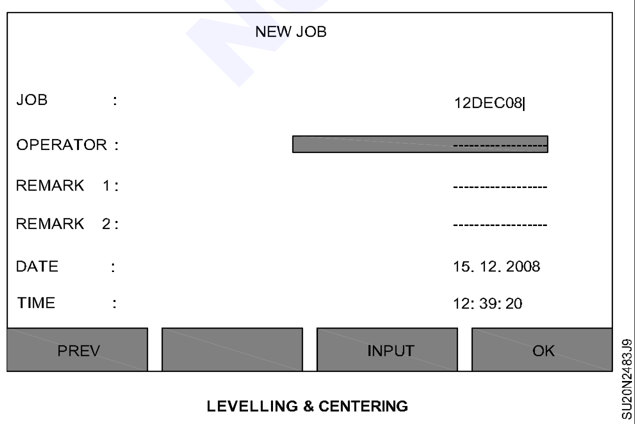
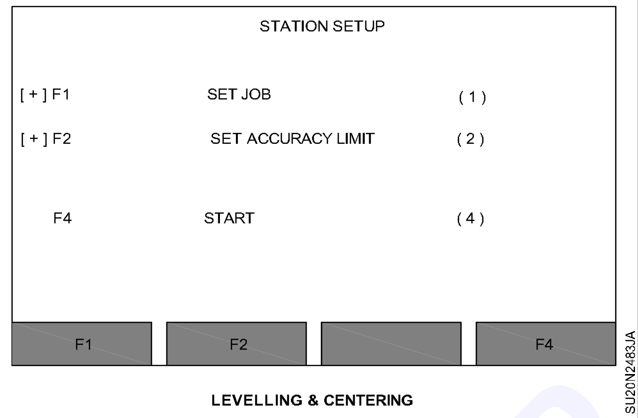


Fig 9



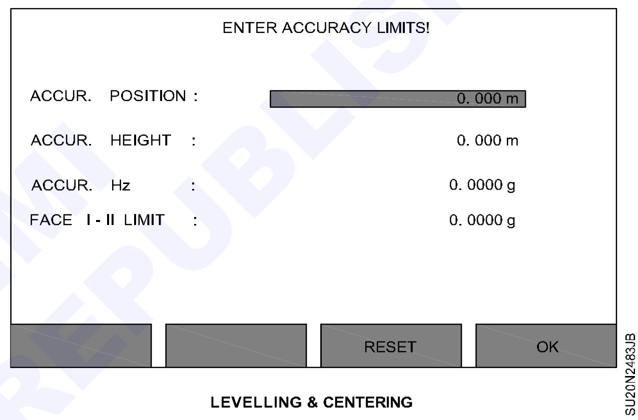
- Press F2 (Set Accuracy Limit) (Fig 10)

Fig 10



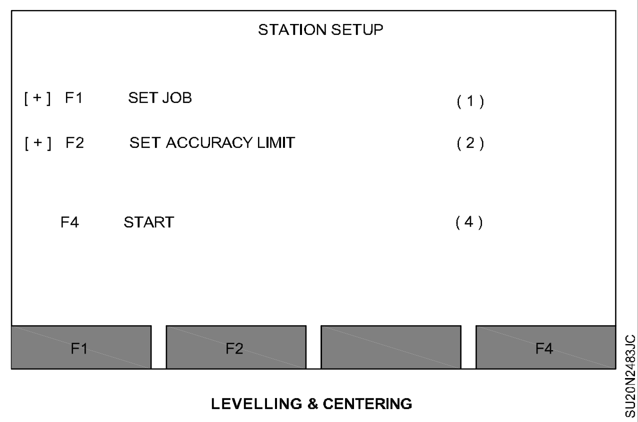
- Press F4 (OK) OR you may give some accuracy limit. (Fig 11)

Fig 11



- Press F4 (START)(Fig 12)

Fig 12



- Now select the method of orientation suppose you are selecting the back sight coordinate Method and Press F3 New station.(Fig 13)
- Press F4(OK)(Fig 14)

Fig 13

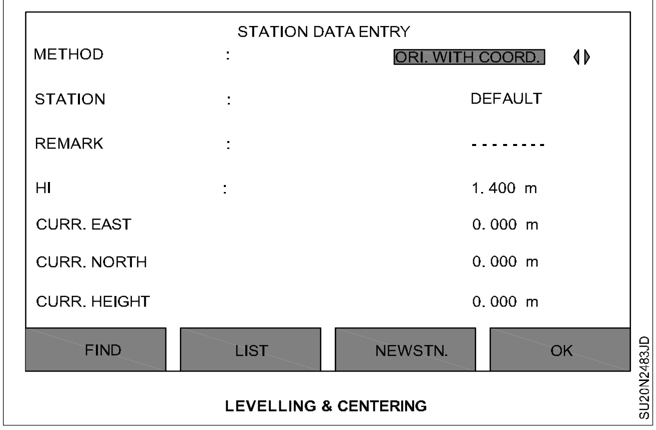
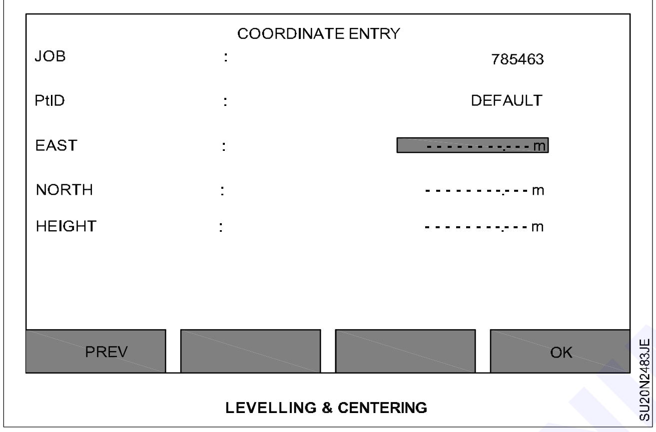
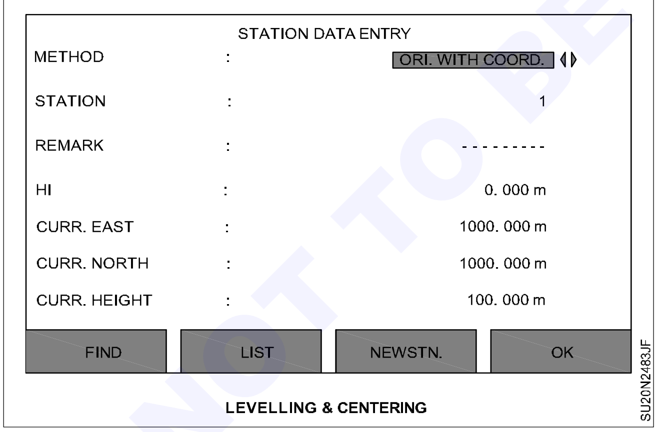


Fig 14



- Now give Station Point ID and give the Easting, Northing & Height using key board and press F4 (OK). (Fig 15)

Fig 15



- Now bring the cursor on instrument height HI and measure the instrument height and give the height. Press F4 OK. (Fig 16)
- Now give the back sight point ID or you can select from list if back sight ID is stored in memory and you can also give the new number of point ID pressing F3 (New) and give the coordinate (Fig 16). Suppose your backsight point ID is 2. (Fig 17)

Fig 16

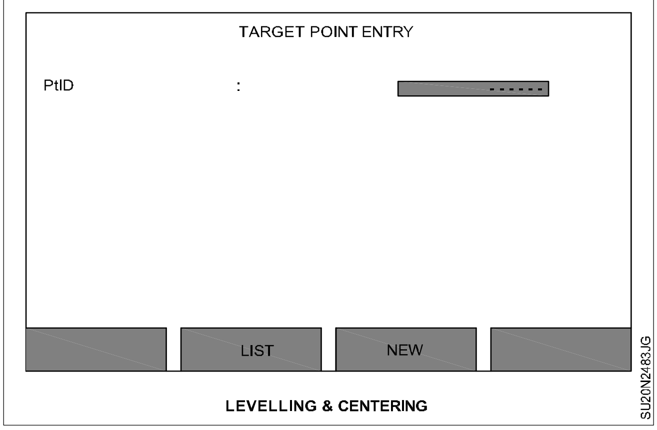
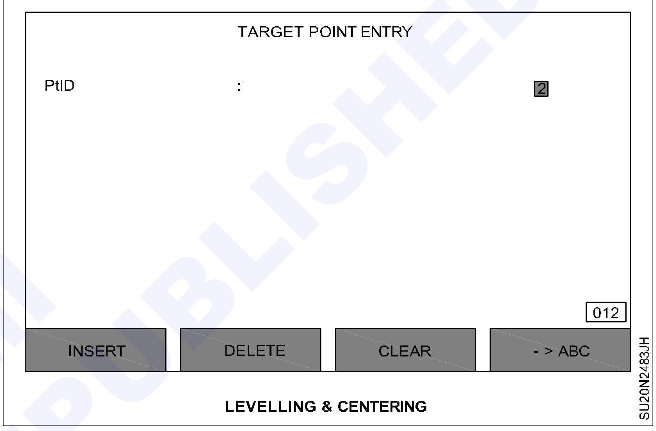
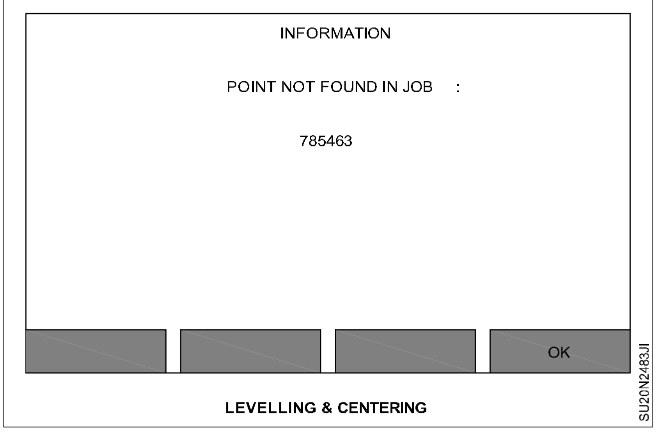


Fig 17



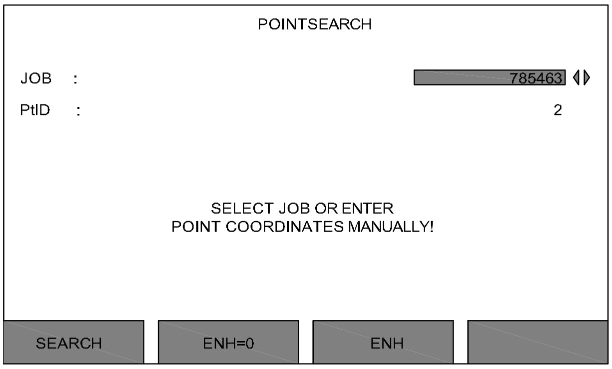
- Press OK. (Fig 18)

Fig 18



- Press F3 (ENH). (Fig 19)
- Give the Easting, Northing and Height of Back side point ID and press F4 OK. (Fig 20)
- Now give reflector height prism say (1. 500m) and sight the prism press DIST you can see your error, then press REC. (Fig 21)
- Press F4 Compute. (Fig 22)

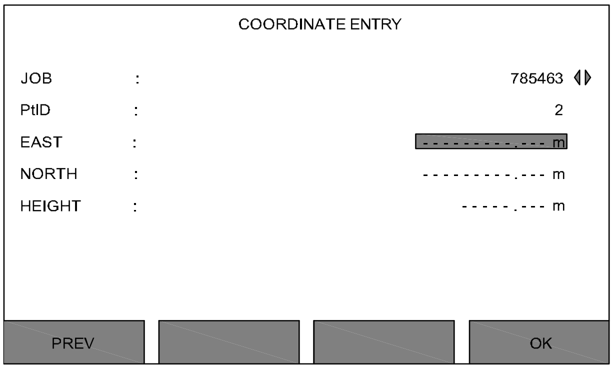
Fig 19



LEVELLING & CENTERING

SU20N2483JJ

Fig 20



LEVELLING & CENTERING

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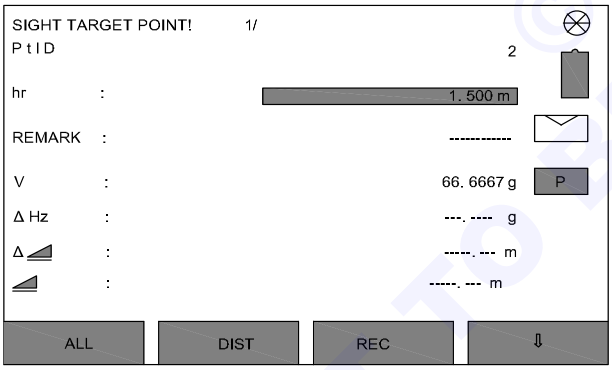
Fig 21



LEVELLING & CENTERING

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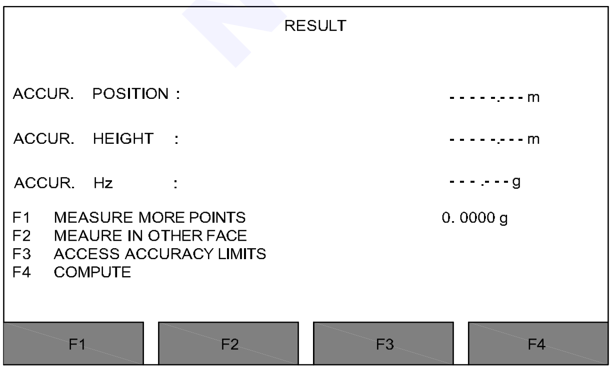
Fig 22

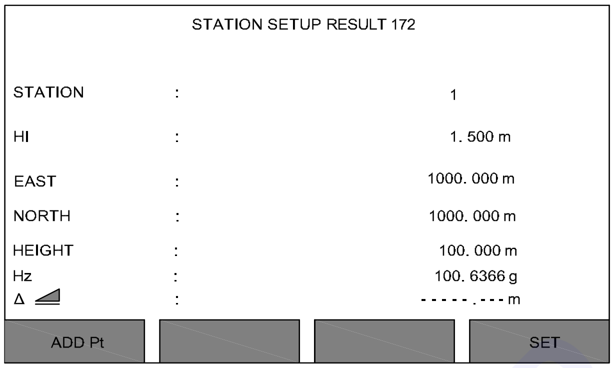


LEVELLING & CENTERING

SU20N2483JM

- Press F4 SET now your station and orientation has been set. (Fig 23) After that you can do any program suppose you are doing surveying.

Fig 23

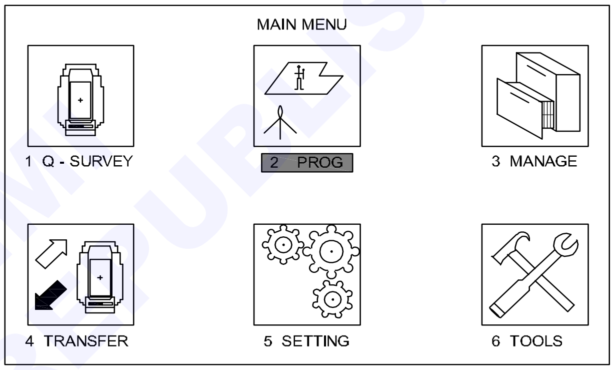


LEVELLING & CENTERING

SU20N2483JN

- In main menu bring the cursor to program icon and press Enter key. (Fig 24)

Fig 24

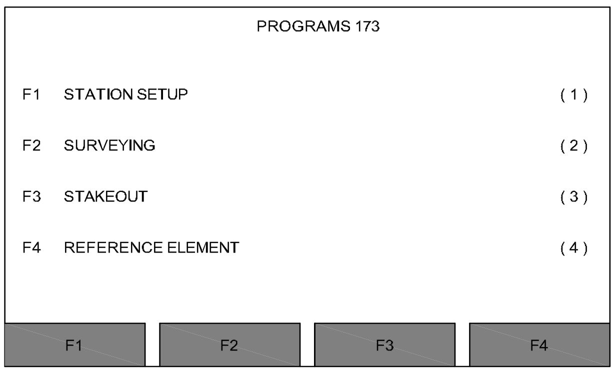


LEVELLING & CENTERING

SU20N2483JO

- Now press F2 surveying. (Figs 25 & 26)
- Since you have set station setup already, press F4 Directly. Now your survey is started. By giving pt ID and 'hr' you can collect data. (Fig 27)
- At last you can start any program in program menu. The state of setup is same for all programs.

Fig 25



LEVELLING & CENTERING

SU20N2483JP

Fig 26

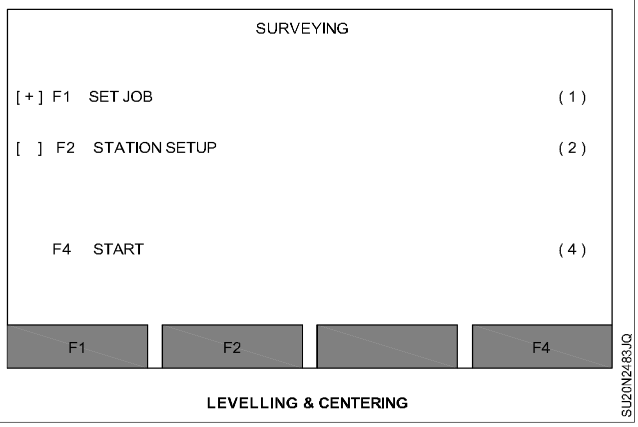
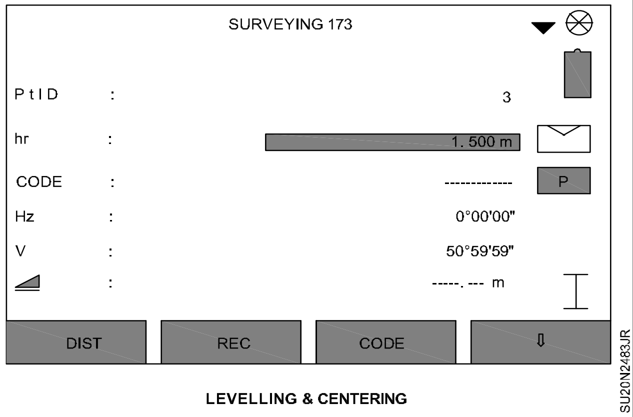


Fig 27



Setting out using total station

Objective : At the end of this exercise you shall be able to

- **set out/ stake out the known coordinate in the field using total station.**

- Establish the total station. Do the centering and levelling. Do the station setup.
- In main menu, bring the cursor in program and press Enter key. (Fig 1)
- Press F3. (Fig 2)
- Press F1 set job.(Fig 3)

Fig 1

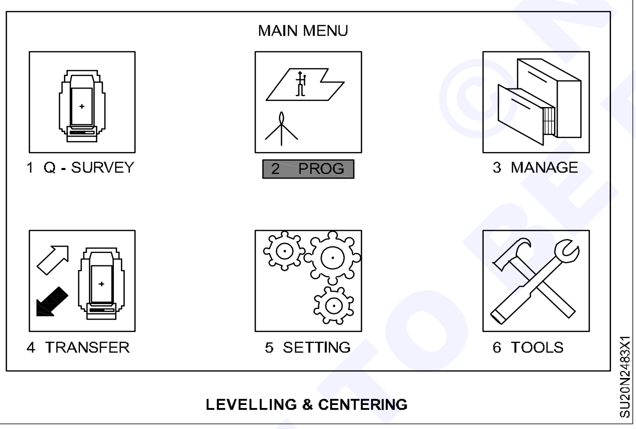


Fig 2

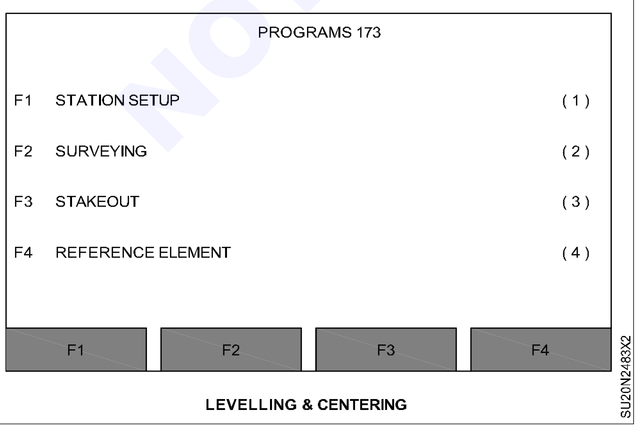
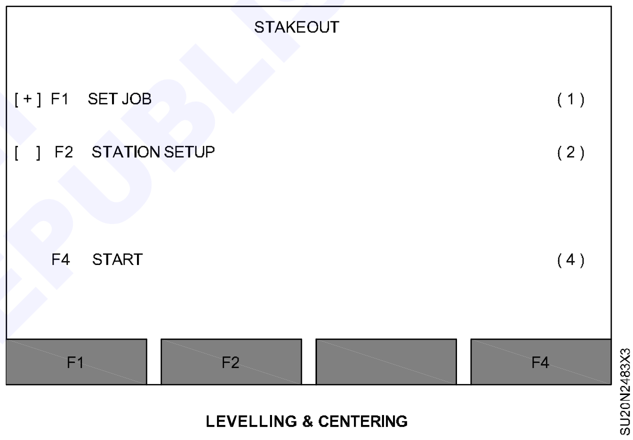
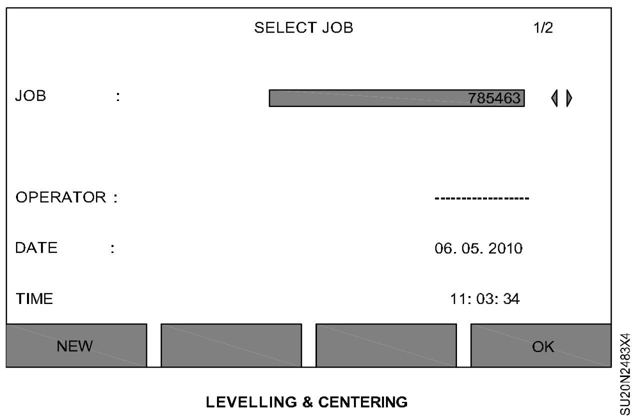


Fig 3



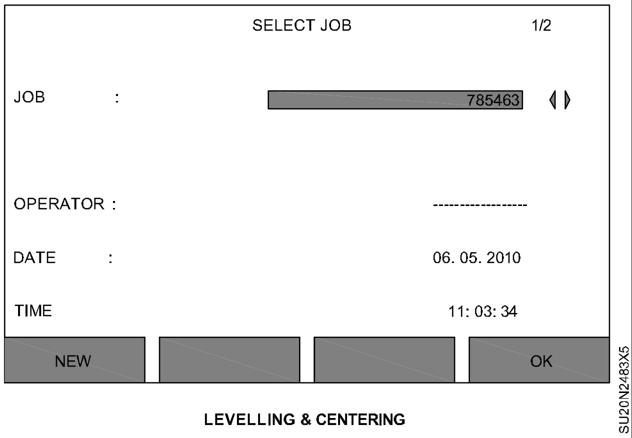
- Press F1 (NEW) and give job name or choose the job from memory and press F1 ok. (Fig 4)

Fig 4



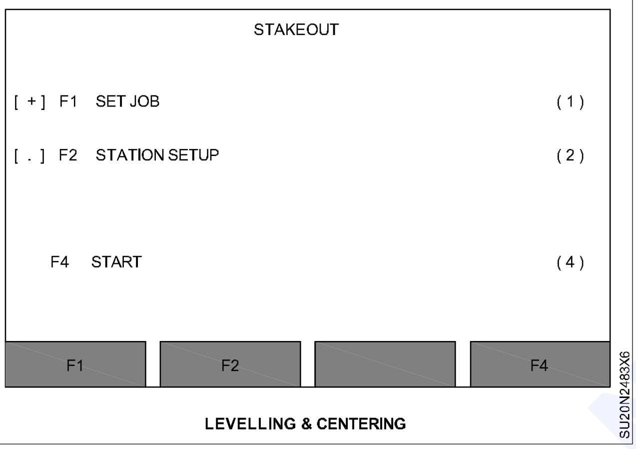
- Press F4 OK. (Fig 5)
- If your station setup is already done then press F4 START. (Fig 6)

Fig 5



LEVELLING & CENTERING

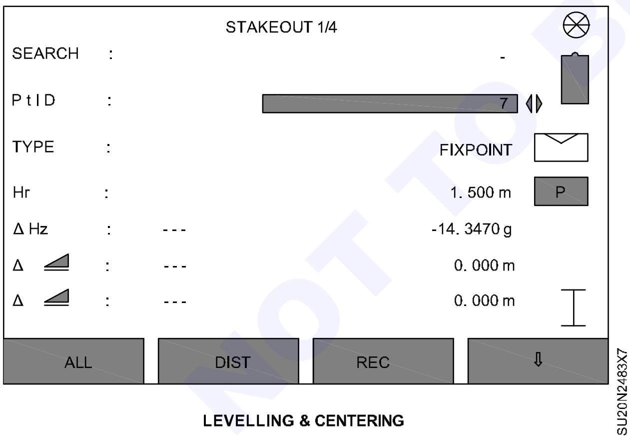
Fig 6



LEVELLING & CENTERING

- After that select the point ID from memory. It will indicate angle & distance. (Fig 7) Make the angle zero.

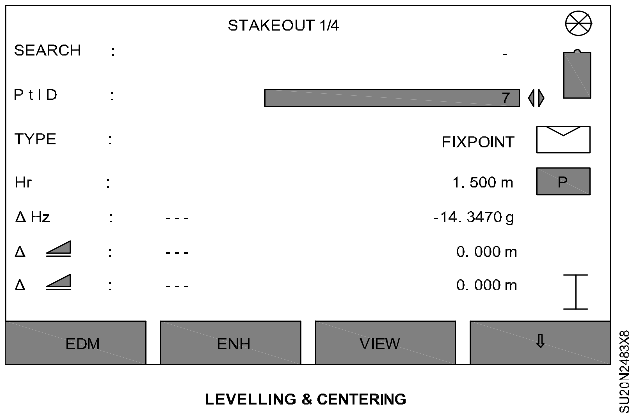
Fig 7



LEVELLING & CENTERING

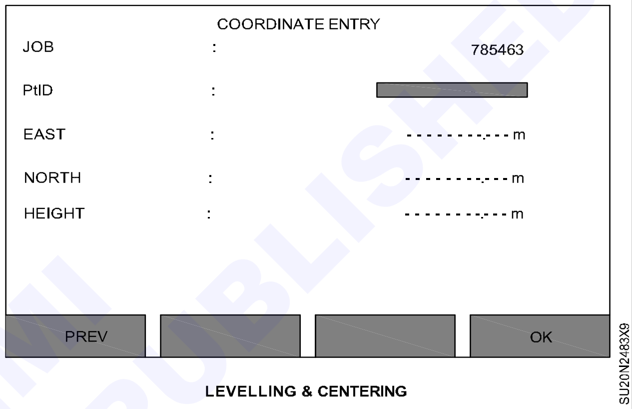
- Mark the new points press F4 arrow key until ENH appears. (Fig 8)
- Press F2 (ENH) (Fig 9)
- Give the pt ID and give the Easting, Northing and Height. And press F4 OK. (Figs 10 & 11)
- Now it is same as before.

Fig 8



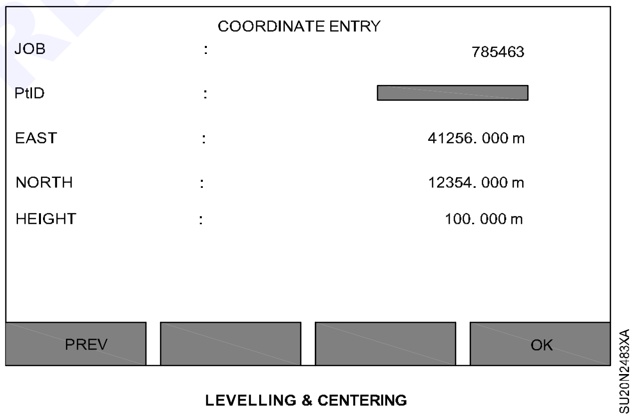
LEVELLING & CENTERING

Fig 9



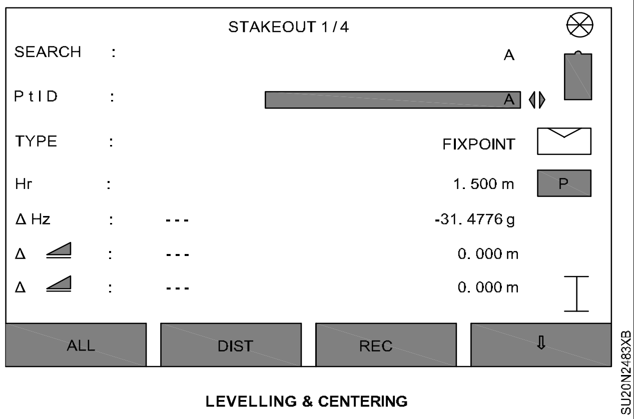
LEVELLING & CENTERING

Fig 10



LEVELLING & CENTERING

Fig 11



LEVELLING & CENTERING

Measurement of horizontal angle and vertical angle

Objectives: At the end of this exercise you shall be able to
- **measurement of horizontal angle**
- **measurement of vertical angle.**

Requirements

Tools/Equipments/Instruments

- Total station in carrying box with tripod, prism and reflector pole.

Materials

• Survey note book	- 1 No.
• Pencil	- 1 No.
• Eraser	- 1 No.

TASK 1: **Measurement of horizontal angle by total station**

1 Select the sight for taking horizontal angle.

2 Set the instrument at 'O' and complete the temporary adjustment.

3 Set the instrument in north direction using compass and carry coordinates through survey by using back sights.

4 Set the instrument measured from zero direction on the horizontal scale.

5 At the same time, the instrument show true north

6 Select a point 'A' and fix a ranging rod at 'A'

7 Set 'zero' direction.

8 Sighting to another B.M

9 Fix another point 'B'

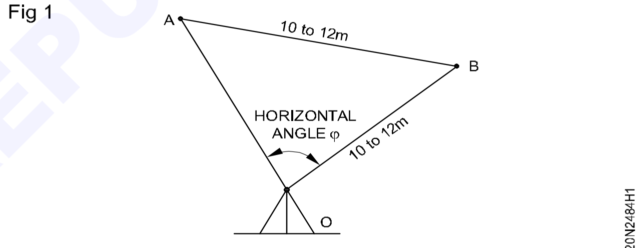
10 Sight 'B' by turning the instrument horizontally.

11 Note down the reading in degrees.

12 $\angle$AOB is the horizontal angle between the points A and B (Fig 1).

The least reading of horizontal angle from total station angle is 5sec.

Fig 1

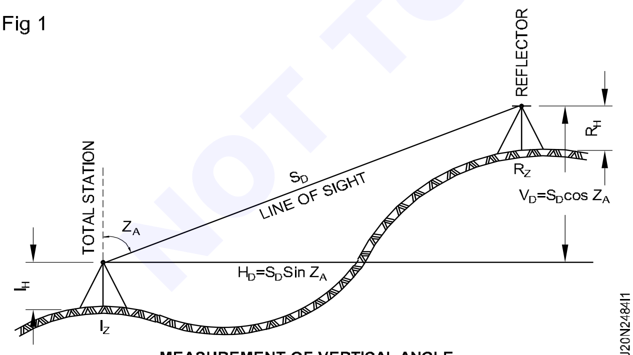


MEASUREMENT OF HORIZONTAL ANGLE

— — — — — — — — —

TASK 2: **Measurement of vertical angle by total station (Fig 1)**

Fig 1



MEASUREMENT OF VERTICAL ANGLE

Data

I = Instrument

R = Reflector

SD = Inclined slope

VD = Vertical distance between telescope and reflector

HD = Horizontal distance

ZA = Zenith angle

I_H = Instrument height

R_H = Reflector height

I_Z = Ground elevation of Total station

R_Z = Ground elevation of Reflector

Vertical angle = 180° - ZA

1 Select the site to measure vertical angle by total station.

2 Set the instrument at 'I' and complete the temporary adjustment.

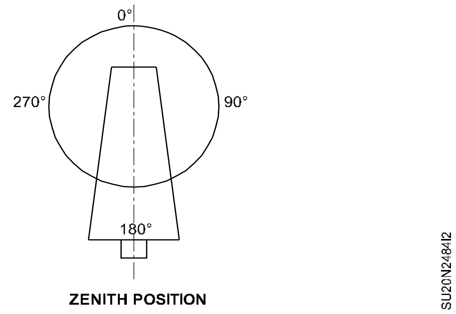
The instrument is perfect/exactly vertical. We can get correct reading. The total station containing internal sensor that can detect small divisions of verticality.

3 The vertical angle is usually measure as zenith angle. 0° vertically up, 90° horizontal and 180° vertically down (Fig 2).

4 Fix target 'R' for the vertical angle.

5 Turn the telescope to sight the target 'R' from zenith position.

Fig 2

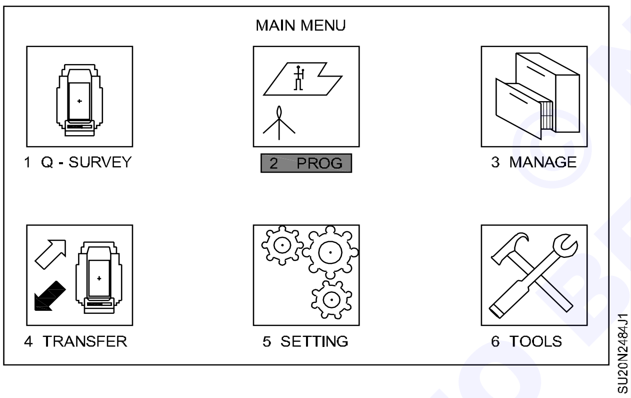


Resection using total station

Objective: At the end of this exercise you shall be able to
- **setup the station using resection program in a total station.**

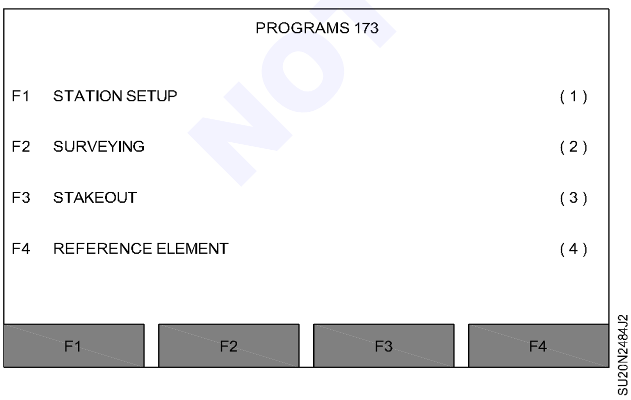
- Establish the total station. Do the centering and levelling and do the station set up. The program free station is used in places where you have the location of two points on the ground and their coordinates but you are keeping the total station at a third place where the coordinates of the station are not known.
- Press MENU
- In main menu, bring the cursor in program and press 'Enter' key. (Fig 1)

Fig 1



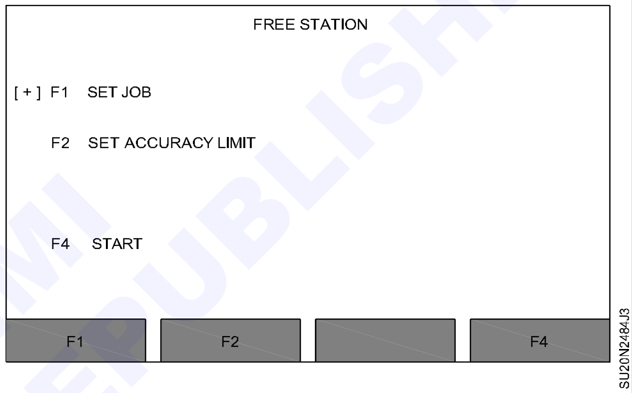
- Press F1 (Station set up). (Fig 2)

Fig 2



- Press F1 (Set job) (Fig 3)

Fig 3



- Enter the Name of the job by Pressing F1 (INPUT)and the using the function keys F1 to F4; enter the name of the job.
- Press F4 (Start).
- In front of the method select Resection with the help of navigation key and press F4 ok. (Fig 4)
- Now we can give the coordinate of the pt ID by pressing new F3 key. (NEW)
- In point ID enter number of the first point where the Prism is kept. (Fig 6)

Fig 4

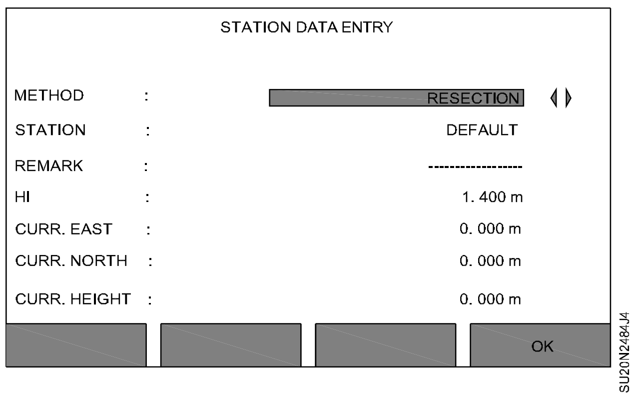


Fig 5

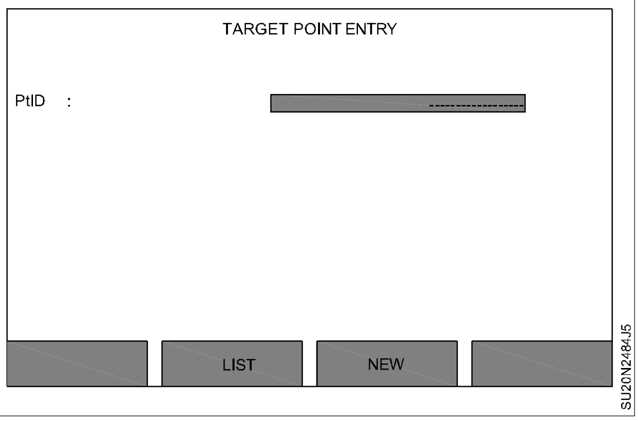
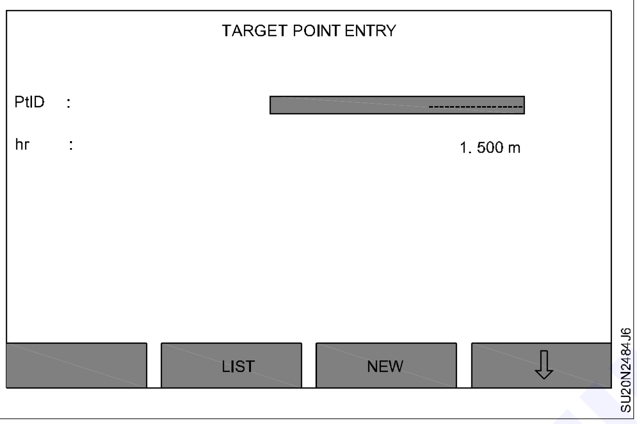
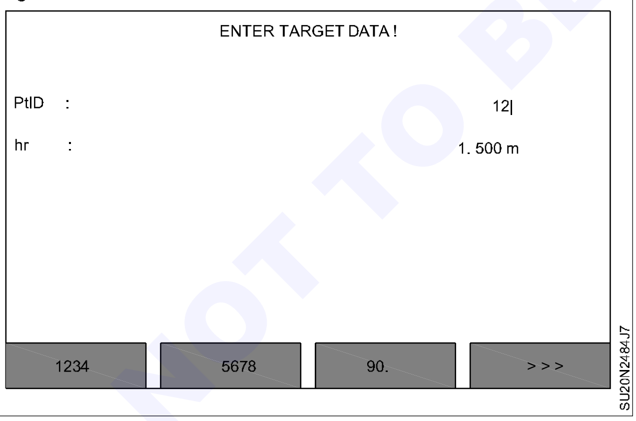


Fig 6



- In front of hr (Height of the Reflector) enter the height to which the prism pole is opened.(Fig 7)
- Press F3 (OK).
- Press F4 (ENH)

Fig 7



- Enter the Easting, Northing and Elevation of the First point. (Fig 8)
- Press F4 (OK).
- Now sight this point and Press F1 (ALL). (Fig 9)
- Press F2 (NEXT PT). (Fig 10)
- In front of pt ID Enter the number of the second point whose location coordinate you know.

Fig 8

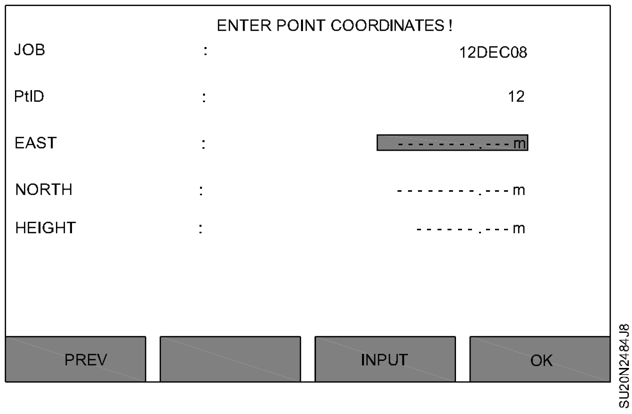


Fig 9

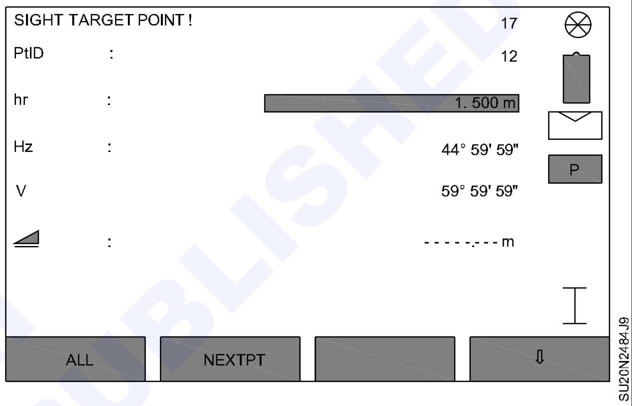
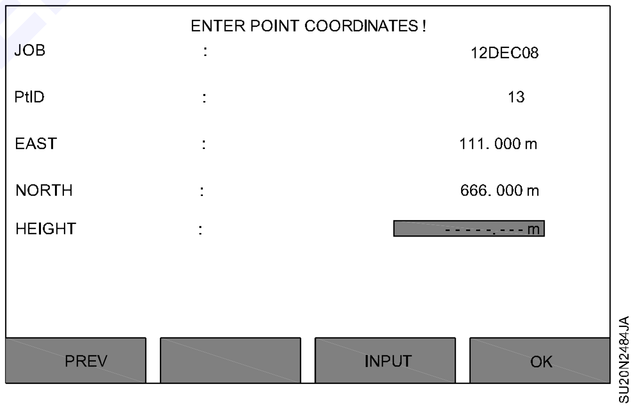


Fig 10



- Press F3 (OK)
- Press F4 (ENH)
- Enter the East, North and elevation of the next point.
- Press F4 (OK)
- Now Sight the point and press F3 (ALL)
- Press F1 (COMPUTE)
- The coordinate of the Instrument station will be displayed to you.

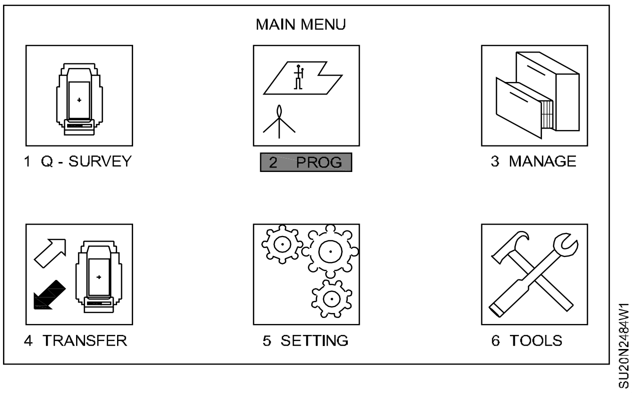
Reference line using total station

Objective: At the end of this exercise you shall be able to
- **set out a new line on the ground with reference to an existing line using a total station.**

Establish the total station. Do the centering and levelling and do the station set up. The Reference Line Program is used to establish points in reference to a base line by using the line and offset values from the first point of the base line. The new line can be parallel, perpendicular or at any angle with respect to the existing base line.

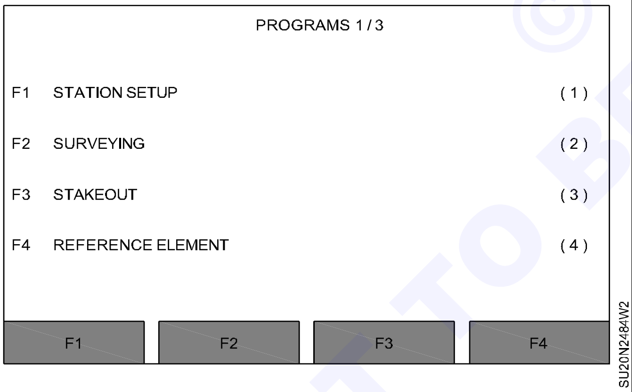
- Press MENU.
- In main menu bring the curson in program and press 'Enter' key. (Fig 1)

Fig 1



- Press F4 (Reference element). (Fig 2)

Fig 2



- Now set the station and orientation by using in the steps given already in station set up method program.
- Press F1 (start). (Fig 3)
- Now put the prism on the first point of the base line.
- Press F3 (ALL). (Fig 4)
- In front of the Point 2 enter the number of the last point of the base line.
- Now sight the point and press F1 (ALL). (Fig 5)
- Press F2 (STAKE). (Fig 6)

Fig 3

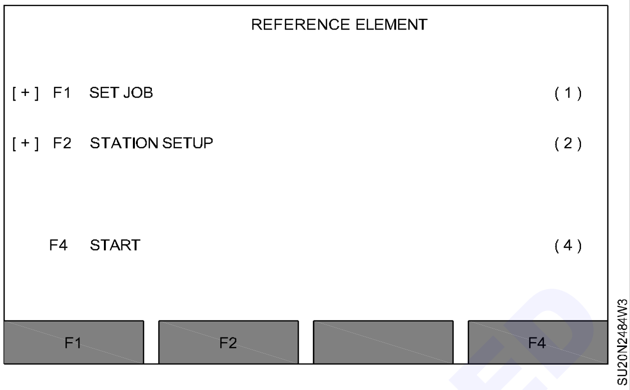


Fig 4

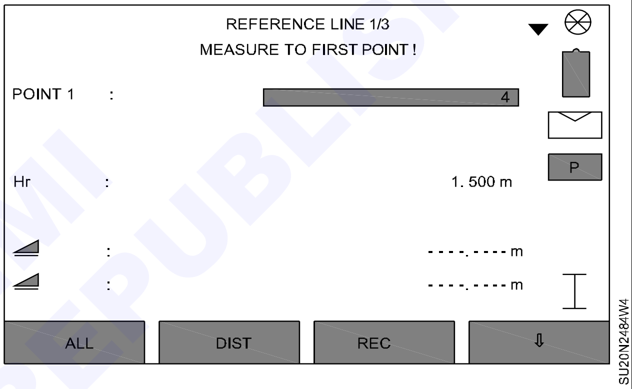
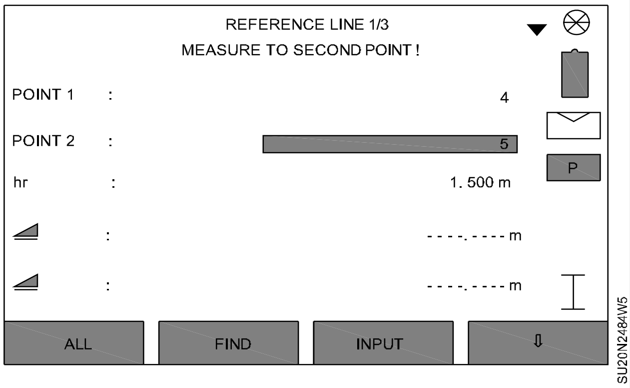


Fig 5



- Now enter the values of the offset and line with respect to the baseline first point. (Fig 7)
- Input center line distance in 'LINE'. (Fig 8)
- Input Offset value If you want to input right side value then input say 5.00 if you want to input left side value then input say - 5.00 in front of OFFSET. (Fig 9)

Fig 6

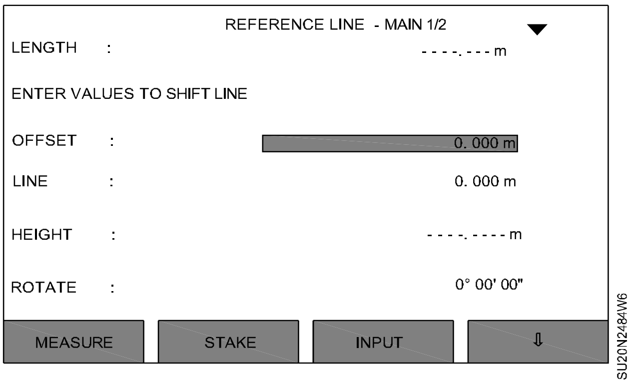


Fig 7

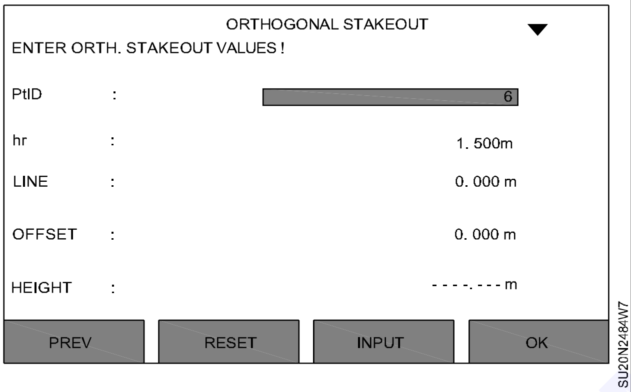


Fig 8

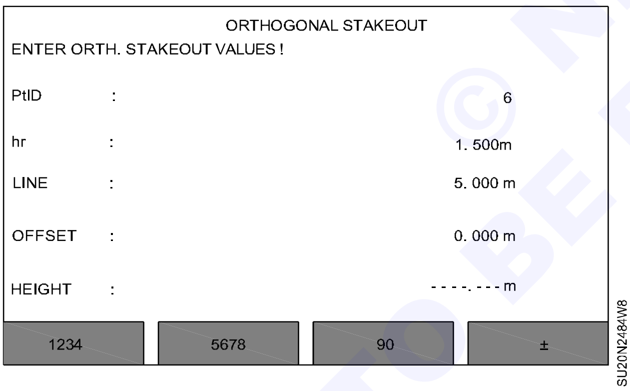
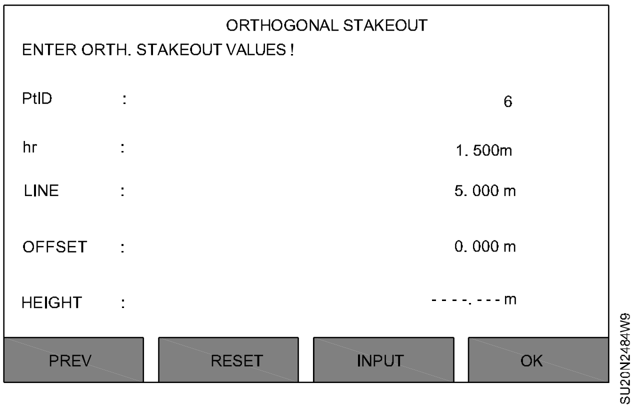
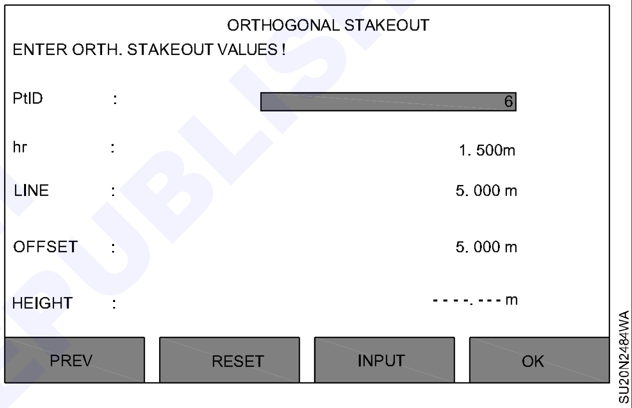


Fig 9



- Press F4 (OK). (Fig 10)
- Now the rest process is same as the stake out process.

Fig 10



Tie distance using total station

Objective: At the end of this exercise you shall be able to
- **compute the distance bearing and grade between two points using a total station.**

Establish the total station. Do the centering and levelling. Do the station setup. The tie distance program is used to find the horizontal distance between two points either by measurement in the field or by the coordinates of the points are present in the memory.

- Press Menu.
- Program. (Fig 1)
- Press PAGE. (Fig 2)
- Press F1 (Tie Distance). (Fig 3)
- Press F4 (Start). (Fig 4)
- There are two types, distance Polygonal and Radial.
- POLYGON is the point-to-point distance whereas the RADIAL is used for finding the distance from a single point being kept fixed. We select here F2 (polygon). (Fig 5)

Fig 1

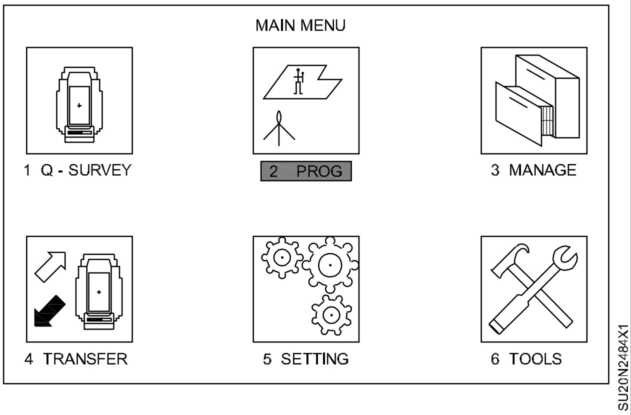


Fig 2

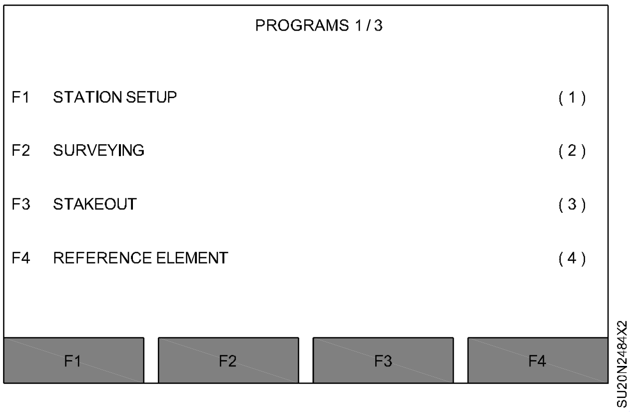


Fig 3

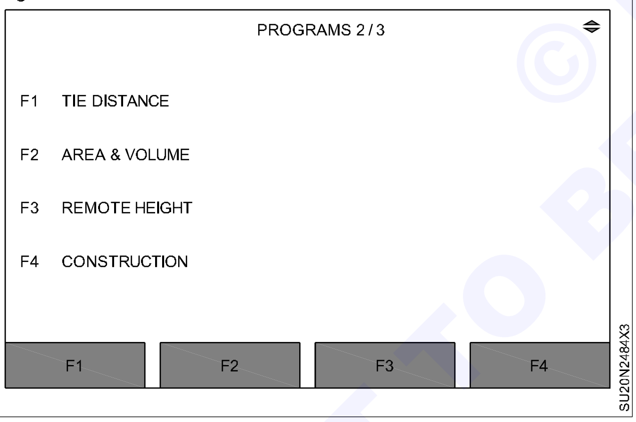


Fig 4

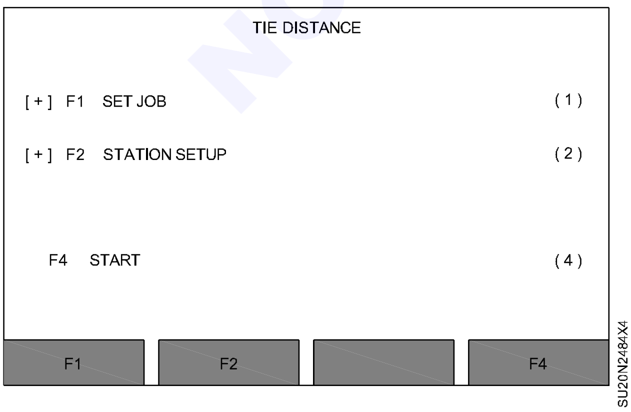
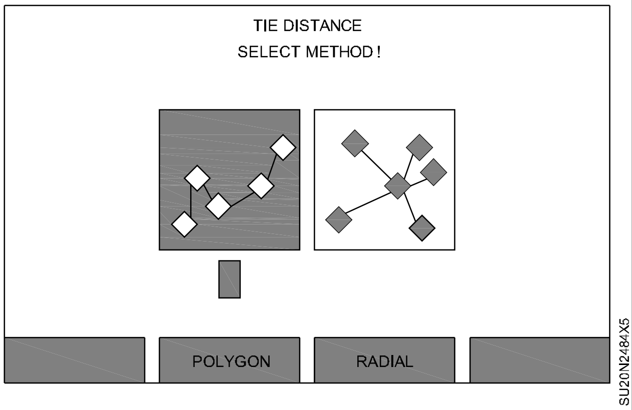
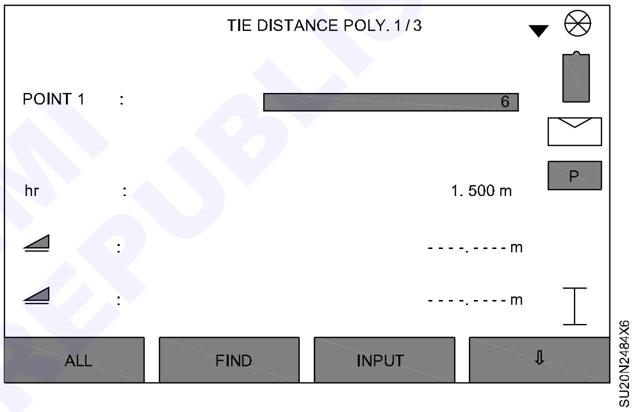


Fig 5



- When the points are not in memory and you want to operate the program by taking the measurements from field.
- In front of (Point 1) enter the number of the point and press F1 (ALL). (Fig 6)

Fig 6



- In front of the Point 2 Enter the number of the Second point sight it and Press F1 (ALL). (Fig 7)
- Now you can see the results displayed on the screen. (Fig 8)

Fig 7

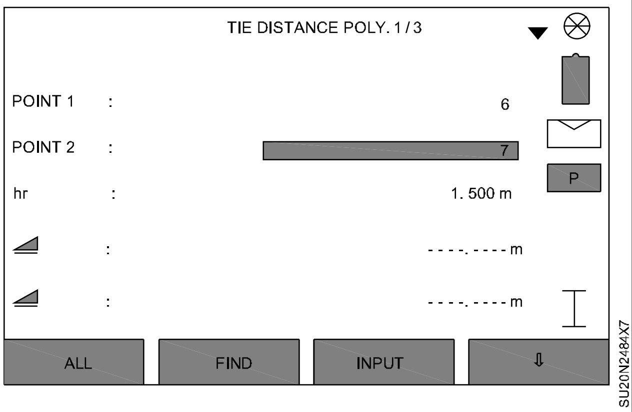
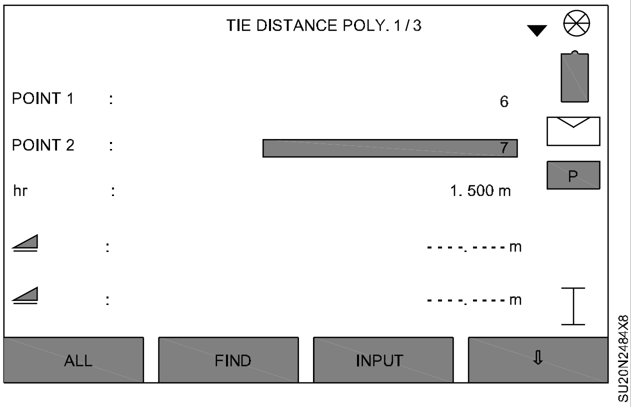


Fig 8



- When the coordinates of the points are already in the memory.
- In front of the point enter the number of the first point and press F2 (FIND)
- If the Point is in the memory it will be found then press F4 (OK)
- In front of POINT 2 Enter the number of the Second point again Press F2 (FIND)
- Press F4 (OK)
- The results are displayed on the screen.

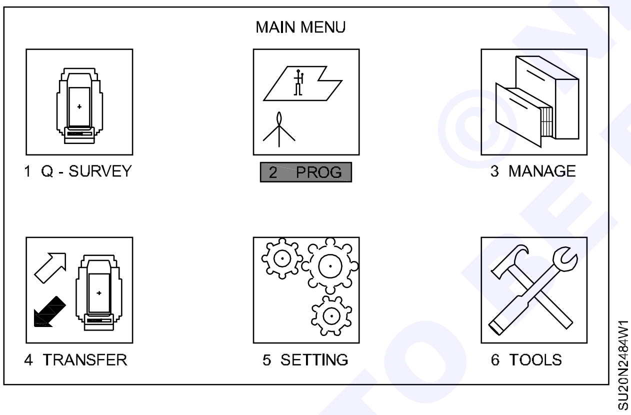
Area computation using total station

Objective: At the end of this exercise you shall be able to
- **compute the area of a plot in the field itself using a total station.**

Establish the total station. Do the centering and levelling. Do the station set up.

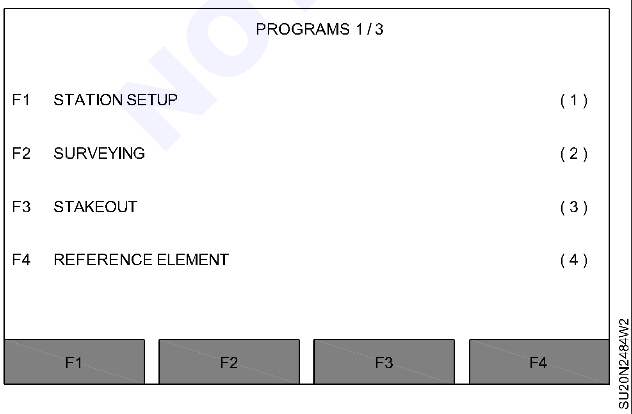
- Press MENU.
- In main menu, bring the cursor in program and press 'Enter' key.(Fig 1)

Fig 1



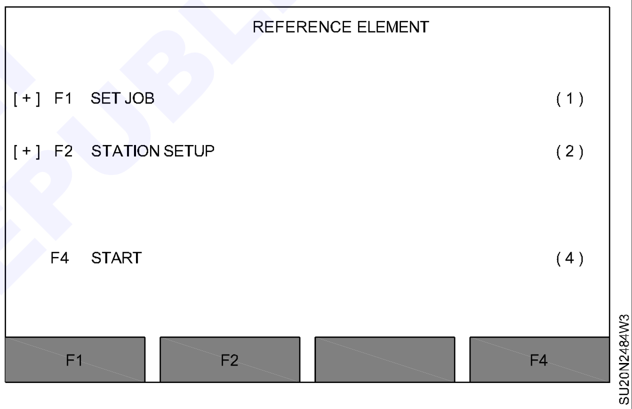
- Press PAGE. (Fig 2)

Fig 2



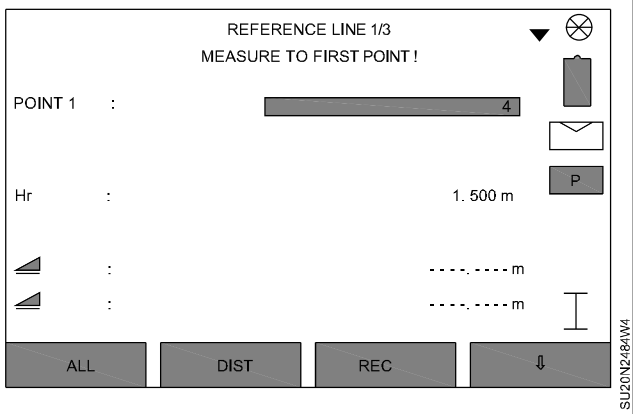
- Press F2 (Area). (Fig 3)

Fig 3



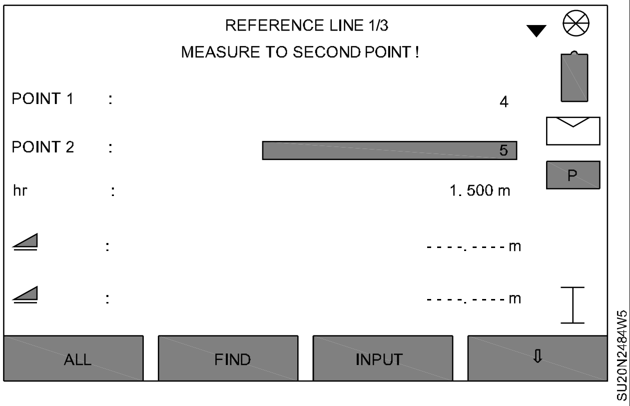
- Set the station and orientation by using the steps given already station set up method program.
- Press F4 (Start). (Fig 4)
- The points whose area is to the found can taken from the memory or can be sight directly in the field.

Fig 4



- In front of Pt ID Enter the number of the first point press F1 (ALL). (Fig 5)

Fig 5



- Keep on sighting the points in a proper sequence until you have all the points. Once you have sight all the points of enclosing area, Press F2 (RESULT). The results are displayed on the screen.

If the point whose area is to be found is already in the memory.

In front of the Pt ID enter the number of the point, which forms the enclosed area.

- After entering the point number, press FIND
- Press F4 (OK)
- Keep repeating this procedure until you have all points imported in the point and press RESULT.
- The results will be displayed on the screen.

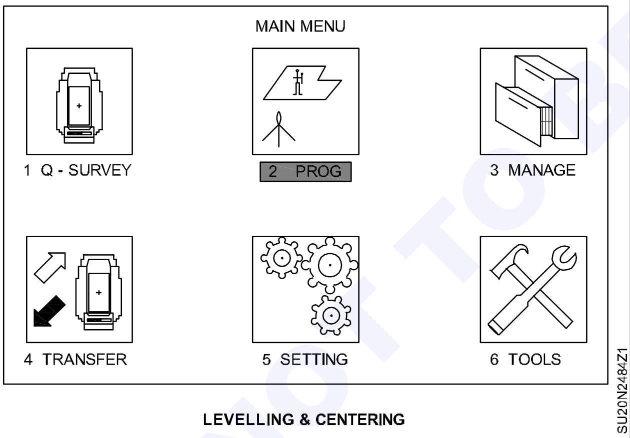
Height of inaccessible point using total station

Objective: At the end of this exercise you shall be able to
- **compute the height of an inaccessible point from the ground point using total station.**

Establish the Total Station. Do the centering and levelling and do the station set up. The Remote Height program is used to find the elevation of the remote points where it is possible to place the prism directly below the point whose remote elevation is to be found.

- Press menu
- In main menu, bring the cursor in program and press 'Enter' key. (Fig 1)

Fig 1



- Press PAGE. (Fig 2)
- Press F3 (Remote Height). (Fig 3)
- Now put the prism on the base point and sight it and press F4 (START). (Fig 5)
- Now move the telescope and focus the top point whose elevation is to the found.
- The height value will be displayed on the screen.

Fig 2

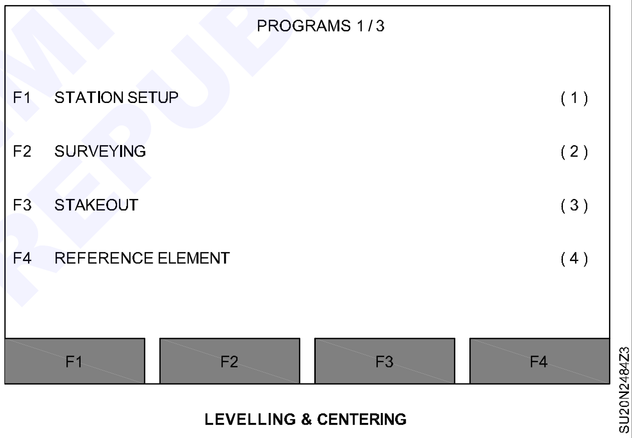


Fig 3

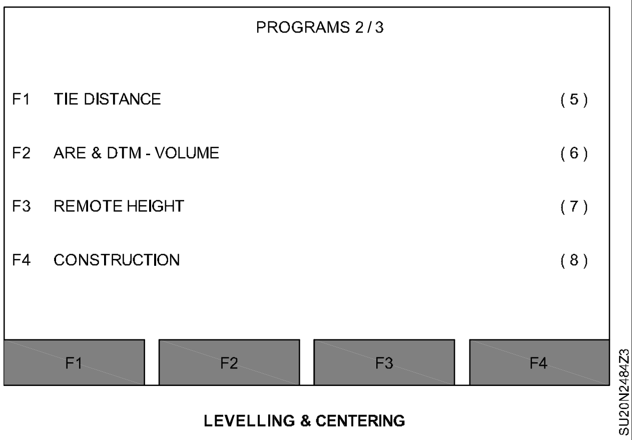


Fig 4

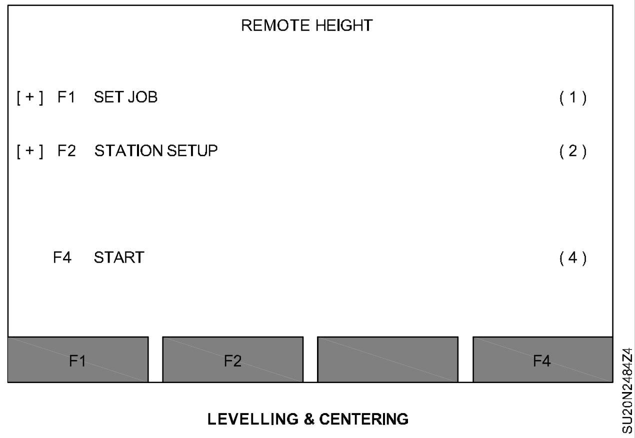
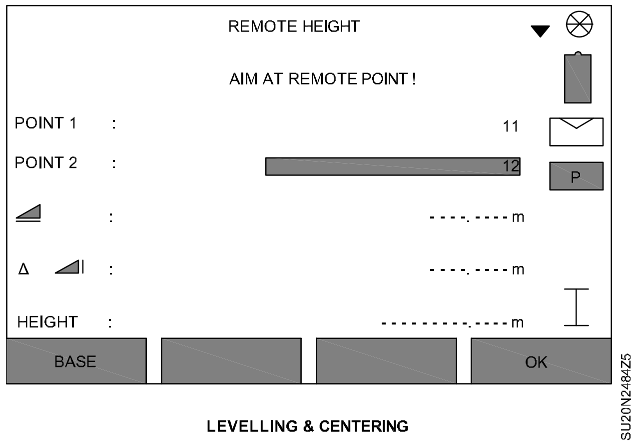

REMOTE HEIGHT
[+] F1 SET JOB (1)
[+] F2 STATION SETUP (2)
F4 START (4)
F1
F2
F4
LEVELLING & CENTERING
SU20N2484Z4

Fig 5


REMOTE HEIGHT
AIM AT REMOTE POINT !
POINT 1 : 11
POINT 2 : 12
P
: - - - -. - - - - m
Δ : - - - -. - - - - m
HEIGHT : - - - - - - - - - -. - - - - m
BASE
OK
LEVELLING & CENTERING
SU20N2484Z5

Traversing using total station

Objective: At the end of this exercise you shall be able to
- **traversing using total station.**

Requirements

Tools/Equipments/Instruments

- Total station with all accessories - 1 No.
- Ranging Rod & Peg - as reqd.

Materials

- Field book - 1 No.
- Pencil - 1 No.
- Eraser - 1 No.

TASK 1: **Traversing using total station**

The direction and length of survey lines are measured with the help of an angular measuring device (Theodolite) and distance measuring device (tape, chain, EDM, GPS etc.,) (Fig 1)

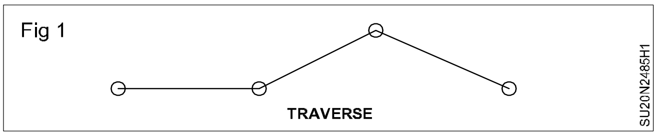


Fig 1

Open traverse

Starts from a known control point and ends at unknown point. (Fig 2)

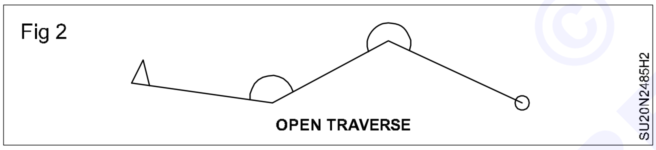


Fig 2

Closed traverse

Starts from and ends at known at control points. (Fig 3)

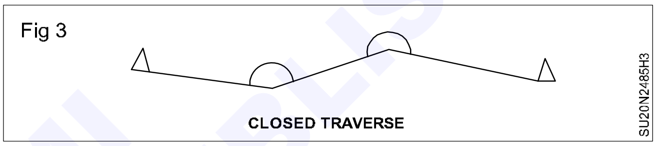


Fig 3

Closed circuit traverse

Starts from and ends at known control point. (Fig 4)

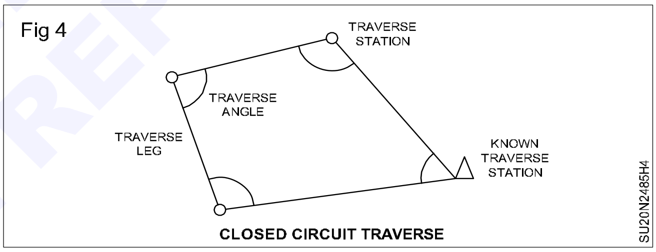


Fig 4

— — — — — — — —

TASK 2: **Traversing using Total station**

1 Establish the total station. Do the centering and levelling and do the station set up.

2 Mark the traverse points on the ground.

3 Place the Reflection pole/Prism pole over the Back sight point.

4 Set new job in Total station and sight the prism pole at back sight point.

5 Orient the instrument and enter the co-ordinates of back sight point.

6 Place the prism over first points of traverse and using total station sight the prism.

7 Measure the angles of traverse point in clock wise or anti-clock wise direction depending on the reference direction used in step 5.

8 Measure the distance of the point.

9 Place the prism over other points of traverse and do the above steps 7 & 8. Record the measurements.

10 After measuring the angle of all traverse points from reference line and distance between the points compute the co-ordinates of each point to the traverse using suitable methods.

11 For closed traverse: Check the closure of the traverse by adding up the interior angles and comparing them with the expected value. If there is error adjustments need to the made.

— — — — — — — —

Download survey data and plotting

Objectives: At the end of this exercise you shall be able to
- **download the survey data given by the instructor**
- **as per data plotting should be done.**
- **download survey data from total station to a computer and then plot**

Requirements

Tools/Equipments/Instruments

- Computer, total station, download cable etc.

PROCEDURE

1 Connect the Total station to compute using appropriate interface cable (or) wireless connection.

2 Make sure the computer recognize the instrument.

3 Open the software provided with the Total station in the computer. This software will allow to download the survey data from total station.

4 Depending on the software this may involve selecting a download option, specifying the file format & location. Then conforming the transfer.

5 Review the downloaded survey data to ensure it is complete and accurate.

6 Using plotting software plot the traverse using the data collected from total station.

Prepare a site plan by the help of mouza map

Objective: At the end of this exercise you shall be able to
- **prepare a map of a village.**

Requirements

Tools/Equipments/Instruments

- Plane table with tripod
- Alidade
- Spirit level
- Trough compass
- Plumbing fork with plum bob
- Measuring (30m) steel tape
- Pegs
- Ranging rods
- Computer with CAD software

Materials

- Drawing sheet A2
- Set of scale
- Pencil, Eraser etc.,
- Cello tape

PROCEDURE

Prepare a map of a village (Open traverse)

1 Select the instrument stations A,B,C etc., after inspecting the site to get rough idea about the village. (Fig 1 showing a typical village)

2 Set up the table 'A'.

3 Centre and level the table and mark point 'a' suitably on the sheets.

4 Mark the direction of the magnetic north on the sheet.

5 Place a ranging rod on station 'B'.

6 Keep the alidade on 'a' sight the ranging rod at 'B'.

7 Draw a ray along the fiducial edge of alidade.

8 Measure the distance AB with tape.

9 Select suitable scale and draw distance 'ab' on sheet.

10 Locate the surrounding details by radiation or intersection.

11 Shift the instrument and set it up at 'B'

12 Centre and level the table.

13 Orient the table by back sighting on 'A'

14 Clamp the table.

15 Place the ranging rod on station 'C'.

16 Keep the alidade pivoted on 'b' sight the station 'C'.

17 Draw a ray along the fiducial edge of the alidade.

18 Measure the distance 'BC' with tape.

19 Set off distance 'bc' on the ray.

20 Locate the surrounding details by radiation or intersection.

21 Proceed the same process until all the remaining stations and surrounding details are to be plotted.

22 Prepare the map drawing using CAD software.

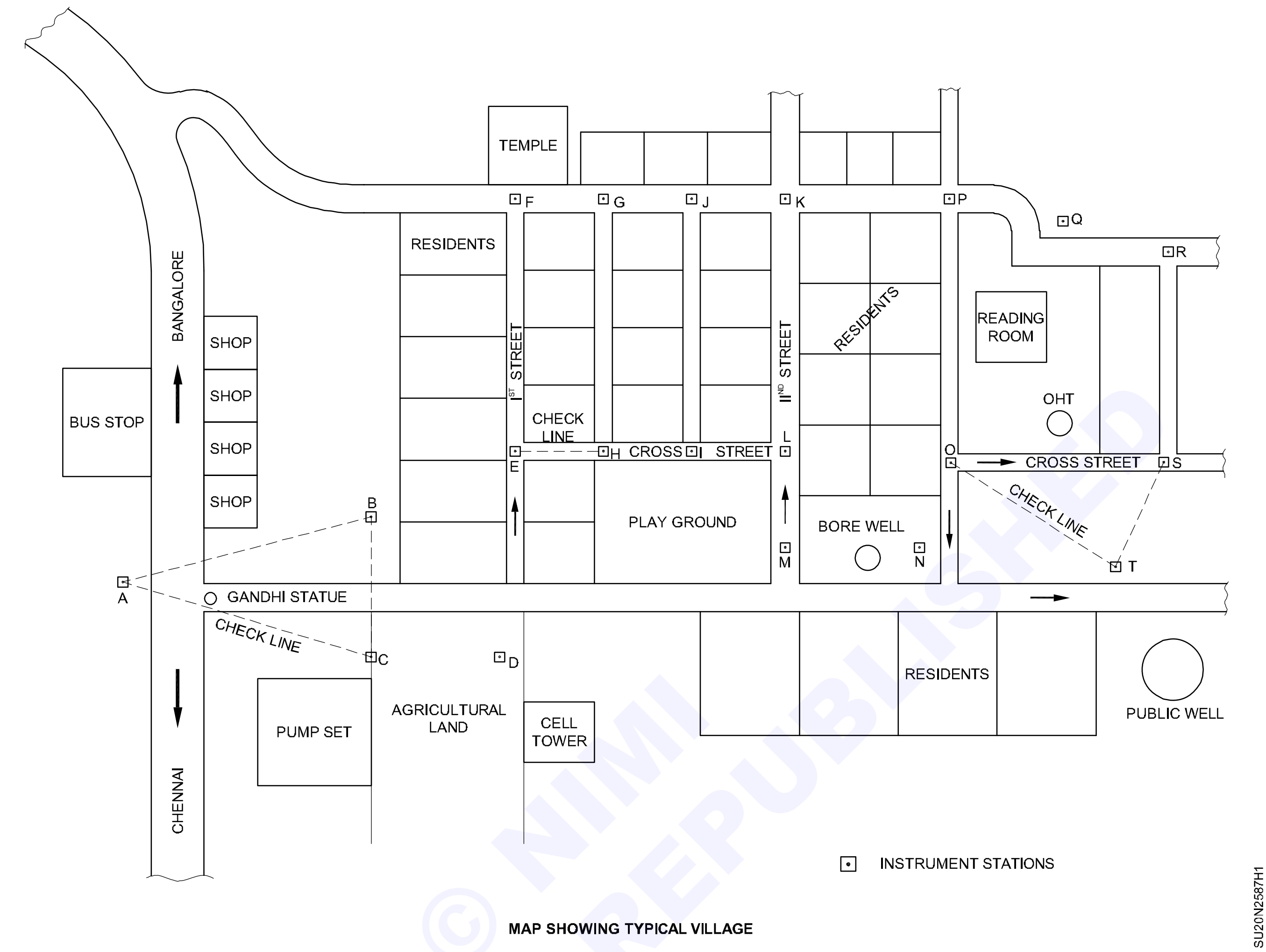
At any station the work can be checked by taking sights to two or more preceding stations visible from the station occupied

When no station is visible then any well defined points or objects such as corner of building electric posts etc., may be used for checking.

Radiation is applicable when the distance between the object and instrument station can be measured easily.

Intersection is applicable when the object is far away from the instrument station which are not possible to measure directly.

Fig 1



MAP SHOWING TYPICAL VILLAGE

Calculate the plot area by digital planimeter

Objective: At the end of this exercise you shall be able to
• **calculate the plot area by digital planimeter.**

Requirements

Tools/Equipments/Instruments

- Digital planimeter - 1 No.

Materials

- Plot area drawing

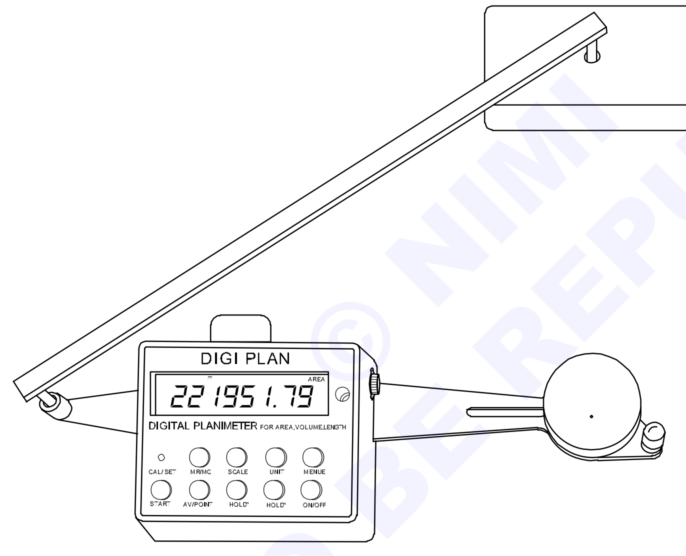
PROCEDURE

Calculate the plot area by digital planimeter

1 Fix the drawing of given plot area.

2 Kept the digital planimeter on the drawing sheet. (Fig 1)

Fig 1



DIGITAL PLANIMETER

3 Kept the tracing arm which manages the position of tracing point at one end.

4 Make necessary unit setting in planimeter.

5 Set the digital reading as zero at the initial level.

6 Use anchor arm to manage the anchor position or needle point position on the plan.

7 Fix the tracing arm in standard length without any extension.

8 Move the tracing needle carefully over the out line of the given plan till the first point is reached.

9 Move the tracing needle in clockwise direction.

10 Note down the reading of first point and the final point.

11 Final reading will indicate the area of given plot area.

Prepare topographical map (direct method)

Objectives: At the end of this exercise you shall be able to
- **prepare topographical map by direct method (vertical control)**
- **prepare topographical map by direct method (horizontal control).**

Requirements

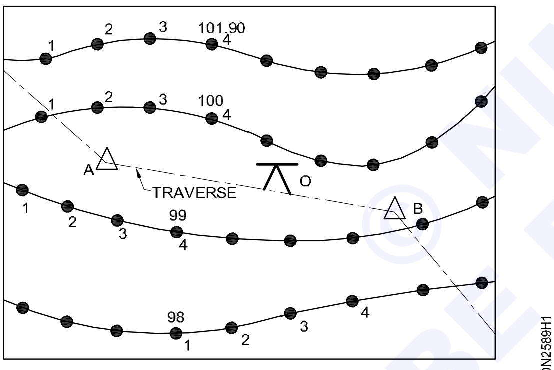
Tools/Equipments/Instruments
- Dumpy level with tripod
- Ranging rods
- Levelling staff
- Tape, pegs
- Plane table with accessories

Materials
- Drawing sheet
- Level field book
- Pencil
- Eraser

PROCEDURE

TASK 1: **Preparation of topographical map by direct method (vertical control) (Fig 1)**

Fig 1



VERTICAL METHOD

1 Select uniform from fairly slope ground.

2 Select fairly equal level points.

3 Set the levelling instrument at the station 'O'

4 Take the staff reading at BM, 101.90m.

5 Determine the height of instrument.

6 Take the staff reading of spot levels which is less than BM 101.90m.

Having the known height of collimation/ instrument the reading is calculated so that the bottom of levelling staff reading is coincide with the required contour line level.

7 Take spot levels 1,2,3,4 of 98.00m.

8 Take spot levels at 1,2,3,4 similarly at 99.00m, 100.00m etc.,

9 Contour lines as already spotted in field work.

10 The spot levels reading must be in the respective contour levels.

11 While taking reading; if the levels are differ and more than the limit direct the staff man to shift the staff at suitable spot.

12 Change the instrument at a station point 'B' by traverse.

13 Take the levels according to the contour line levels.

14 Plot the contour lines of the area with field work of level readings.

15 Contour lines indicate, the topographical of the area.

— — — — — — — —

TASK 2: **Preparation of topographical map by direct method (horizontal control) (Fig 1)**

1 Locate the contour points roughly in same horizontal line (5 to 6 points)

2 Locate another 5 to 6 points roughly in say 496m level.

3 Locate the points 497, 498, 499m.

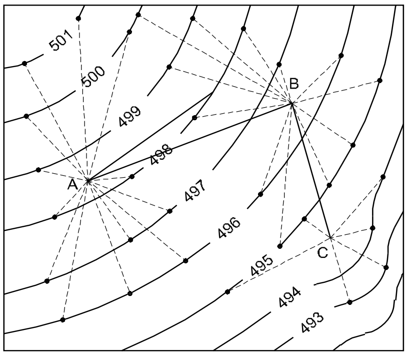
4 Indicate the identification of each points in each level.

5 Use arrows, and the arrows has paper tag with point identification

6 Set the plane table at station 'A' and view more area of contour level.

7 Draw the rays by radiation method above said 5 or 6 points.

Fig 1



SURVEYING LOCATIONS OF CONTOURS

8 Measure the distance of the points from the plane table station.

9 Shift the plane table at 'B' station, back sight in the old station 'A'

10 Set up the plane table.

11 Measure the distance in between the station A and B.

12 Higher level points sighted with telescopic alidade.

13 If A and B stations are not sufficient to cover contour points, proceed with traverse method and find out the points.

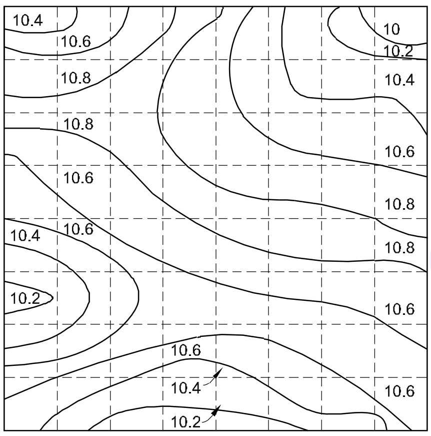
14 Complete the field in drawing sheet.

Prepare topographical map (indirect method)

Objectives: At the end of this exercise you shall be able to
- **prepare topographical map by indirect method (vertical control)**
- **prepare topographical map by indirect method (horizontal control).**

TASK 1: **Preparation of topographical map by indirect method (By squares) (Fig 1)**

Fig 1



1 The area should be small and the ground is not very undulating.

Divide the area into number of squares.

2 Divide the square with sides vary from 3 to 5m.

3 Determine the elevation of the corner of square by a level and staff.

4 Small square are enough to conform the inequalities of the ground and to the accuracy required.

5 Enter the staff reading in level field book.

6 Draw contour lines by interpolation of same level.

— — — — — — — —

Make a cadastral/mouza and calculate the plot area

Objectives: At the end of this exercise you shall be able to
- **prepare a polygonal plot by cadastral survey**
- **calculate the area of polygonal plot.**

Requirements

Tools/Equipments/Instruments

- Engineering chain - 1 No.
- Cross staff - 1 No.
- Tape 30m - 1 No.
- Arrows 40cm long - 10 Nos.
- Pegs
- Ranging rod 2/3m, 3cm θ - 5 Nos.
- Metric chain 20m/30m - 1 No.
- Metallic tape or steel tape 30m - 1 No.

Materials

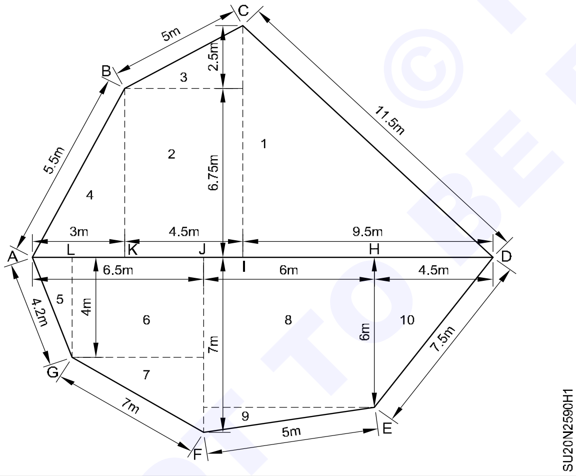
- Field note book
- Pencil
- Eraser
- Set of scale

PROCEDURE

TASK 1: **Prepare a polygonal plot by cadastral survey**

1 Mark the stations A and D, 17m. (Fig 1)

Fig 1



2 Fix the ranging rod A and D

3 Check the perpendicular by cross staff at H.

4 Mark the distance 6m at E

5 Join DE

6 Mark the distance I, 9.5m from D and erect perpendicular at a distance of 9.25m and mark c.

7 Join DC

8 Similarly join the point CB, BA, AG, GF, FE and ED

9 Join all points by straight line.

10 Complete the work.

— — — — — — — —

TASK 2: **Calculate the plot area**

Part 1:

Area of right angled triangle : ½ x base x height

= ½ x 9.5 x 9.25m²

= 43.94m²

Part 2:

Area of rectangle = l x b

= 6.75 x 4.5

= 30.38m²

Similarly to find out all part of plot and find out total plot area.

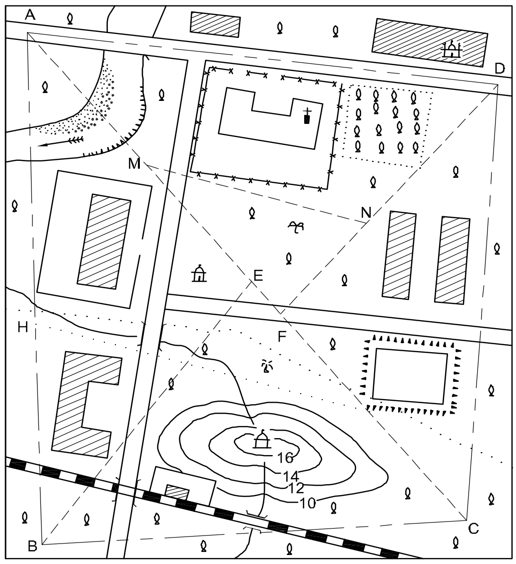
— — — — — — — —

Cadastral survey (various obstacles)

Objectives: At the end of this exercise you shall be able to
- **select the area and survey with chain**
- **calculate the plot area.**

TASK 1: **Select the area, and survey with chain (Fig 1)**

Fig 1



1 Select an area (eg.,) your I.T.I total land area.

2 Select 4 to 6 main chain stations. Each station should be visible.

3 Select number of tie station/subsidiary station points in main chain line, to locate details of place/land.

4 Proceed a chain line diagonally to the main station (or) may join near main chain line

5 Proceed the chain line from station one to other station.

6 While on survey give all details about the land containing the building size and shape. Road width, drainage, pond, transformer, temples, shed and other details.

7 The cadastral survey may done with 4 (or) 5 team having the chain survey tools & equipments.

8 Conduct the survey each team from different main station point to other main station point.

9 Assemble the team compile all chain survey details and plot the total area detail in class room/ drawing room.

10 Finally, the map (survey map) may be of fig1 shown below.

Prepare a detailed road project (more than 1 km)

Objective : At the end of this exercise you shall be able to
• prepare a road map with details along the road.

Requirements

Tools/Equipments/Instruments

- Prismatic compass - 1 No.
- Ranging rods - as reqd.
- Wooden peg - as reqd.
- Chain & tape - 30m with arrows - 10 arrows
- Cross - staff - 1 No.

Materials

- Drawing sheet A3 - 1 No.
- Field book - 1 No.
- Pencil HB - 1 No.
- Eraser - 1 No.
- Cello taps
- Set of scale - 1 Set

PROCEDURE

Prepare a road map with details along the road

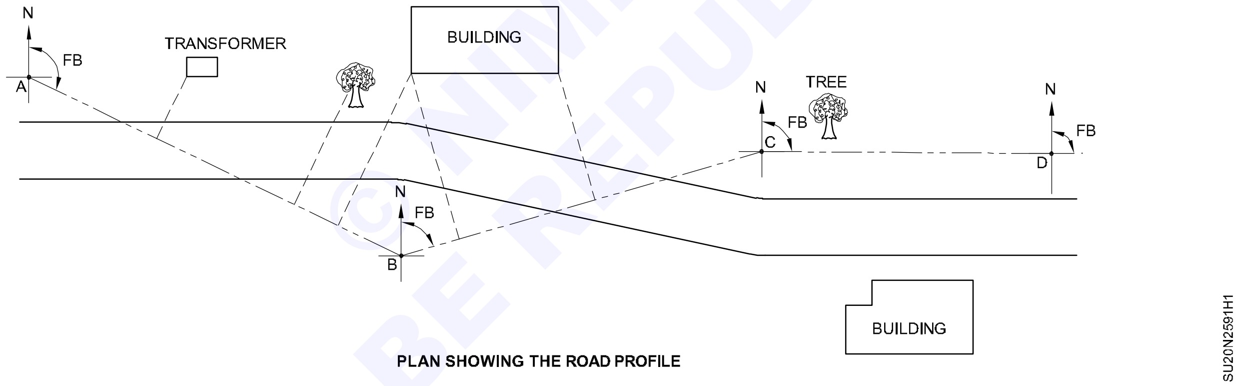
1 Make a visit to the existing road for the purpose of identifying the objects and special features located on the sides of road to be surveyed. (Fig 1)

2 Select an instrument station 'A' at the beginning of road which gives maximum details for mapping.

3 Select the other stations B,C,D etc,.

4 Set up the instrument over the selected station 'A'

Fig 1



PLAN SHOWING THE ROAD PROFILE

5 Fix a ranging rod at station 'B'

6 Sight station 'B' and take the bearing and note it in the field book.

7 Run the chain along 'AB' and take off-sets of the objects on both sides of the road.

8 Observations should be recorded in the filed book.

9 Shift the instrument to station 'B'.

10 Take the bearing by back sighting 'A'.

11 Check it with the fore bearings of 'AB'

12 Fix a ranging rod at 'C'

13 Sight station 'C' and take the bearing of 'BC' and enter it.

14 Run the chain along BC and take offsets of objects on both sides of the road.

15 Similarly the station points as fixed more than 1 km length.

16 All the bearings should be entered in the field book as per the table given below.

17 The offsets taken for different objects are entered as a chain survey field book.

18 Plot the road map based on the bearings and offsets.

Run the survey line along the sides of the road only, to avoid traffic problems.

Model tabulation

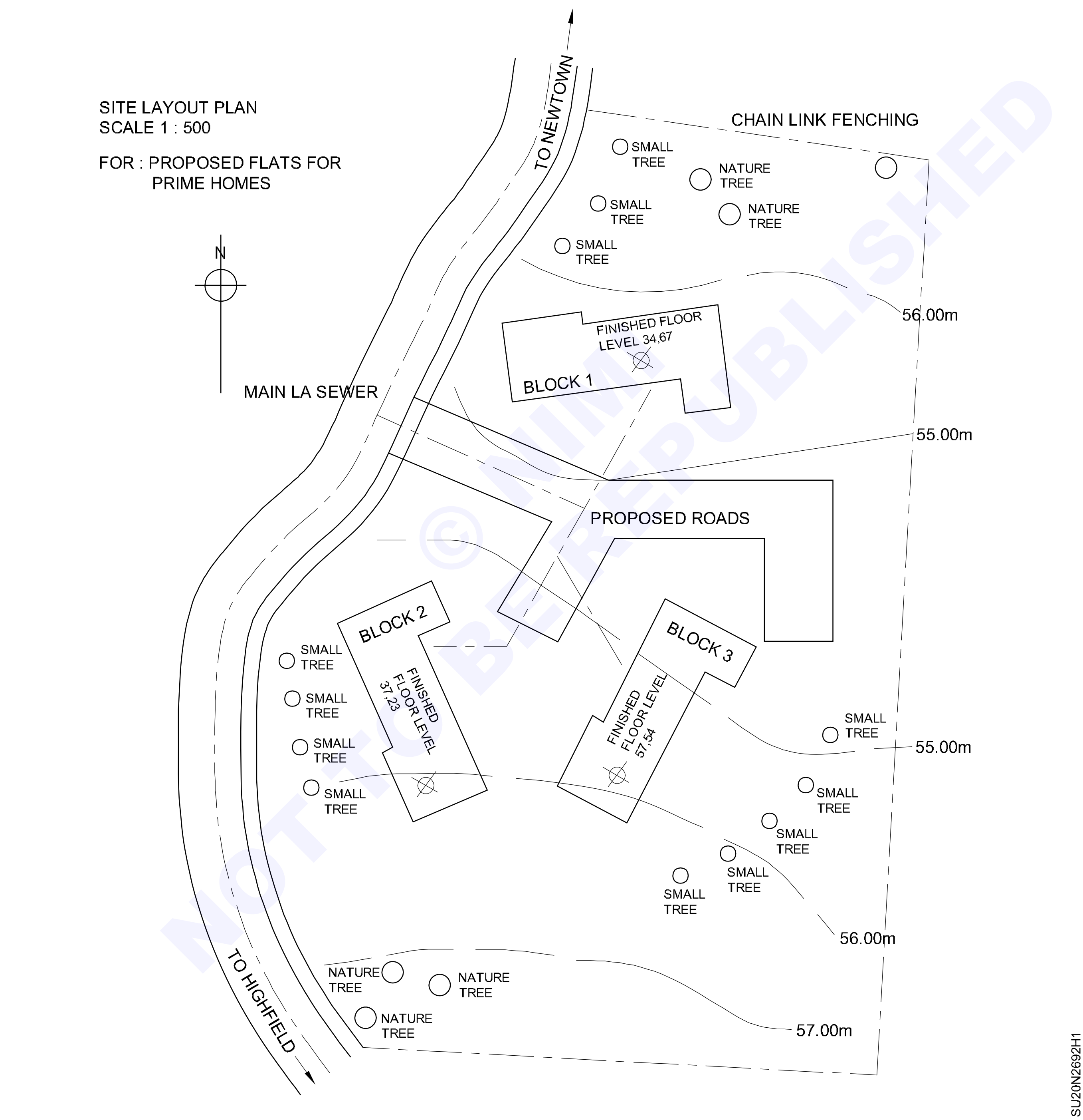
Instrument at	Sight to	Distance in metre	Bearing	Remarks
A	B	....	......	AB
B	A	....	......	BA
	C	....	......	BC
C	B	....	......	CB
	D	....	......	DD

Survey drawing practice using auto cad command

Objective: At the end of this exercise you shall be able to
- **draw the site layout plan of survey drawing using auto cad commands.**

The figure shows the site layout plan, layout with proposed flats for auto CAD commands.

Fig 1

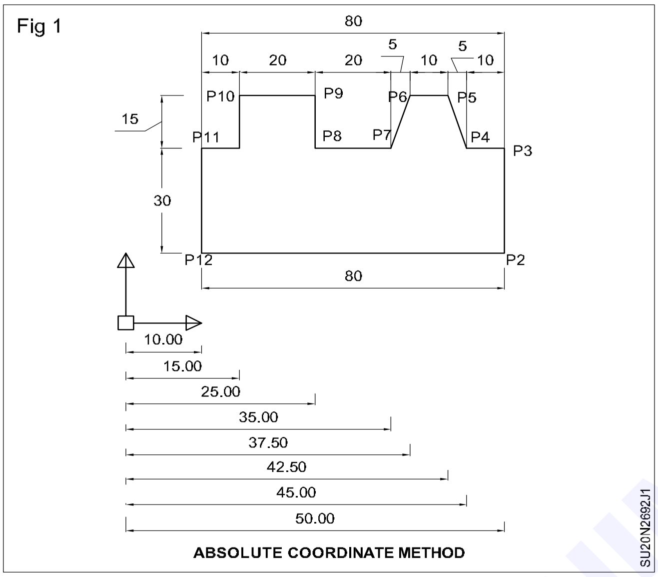


Co-ordinate system

Objectives: At the end of this exercise you shall be able to
- **reset model space limit**
- **draw the given line diagram using absolute co-ordinate method**
- **draw the given figure-using relative co-ordinate method**
- **draw the given figure-using polar co-ordinate method.**

PROCEDURE

TASK 1: **To draw a line diagram absolute coordinate method, follow the steps mentioned below (Fig 1)**



ABSOLUTE COORDINATE METHOD

1 Command : **LIMITS** (↵)

Reset model space limits :

Specify lower left corner or [ON/OFF] <0.0000,0.0000>: (↵)

Specify upper left corner <12.0000,9.0000>: **120,90** (↵)

2 Command : **ZOOM** (↵)

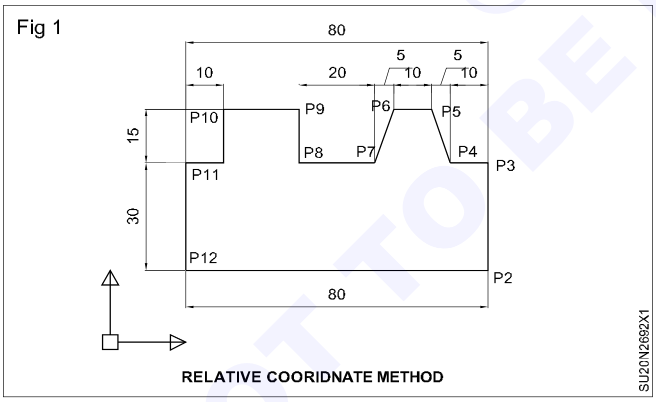
Specify corner of window, enter a scale factor (nx or nXP), or [All/Center/Dynamic/Extents/Previous/Scale/Window] <real time>: All (↵)

Regenerating model space limits

3 Command : **LINE** (↵)

— — — — — — — —

TASK 2 : **To draw a line diagram using relative coordinate method, follow the steps mentioned below. (Fig 1)**



RELATIVE COORIDNATE METHOD

1 Command : **LIMITS** (↵)

Reset model space limits :

Specify lower left corner or [ON/OFF] <0.0000,0.0000> : (↵)

Specify upper right corner <12.0000,9.0000> : **120,90** (↵)

2 Command : **ZOOM** (↵)

Specify corner of window, enter a scale factor (nX or nXP), or [All/Center /Dynamic/Extents/Previous/Scale/Window] <real time>: **All** (↵) regenerating model.

3 Command : **LINE** (↵)

Specify first point : **20,20** (↵)

Specify next point or [Undo]:@**80,0** (↵)

Specify next point or [Undo]:@**0,30** (↵)

Specify next point or [Close/Undo]:@**-10,0** (↵)

Specify next point or [Close/Undo]:@**-5,15** (↵)

Specify next point or [Close/Undo]:@**-10,0** (↵)

Specify next point or [Close/Undo]:@**-5,15** (↵)

Specify next point or [Close/Undo]:@**-20,0** (↵)

Specify next point or [Close/Undo]:@ **0,15** (↵)

Specify next point or [Close/Undo]:@**-20,0** (↵)

Specify next point or [Close/Undo]:@ **0,-15** (↵)

Specify next point or [Close/Undo]:@ **-10,0** (↵)

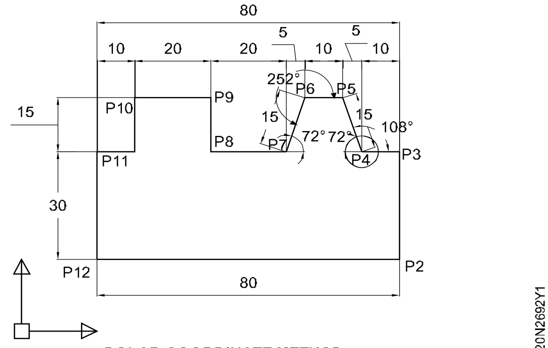
Specify next point or [Close/Undo]: **C** (↵)

4 Save this file.

Output

TASK 3: **To draw a line diagram using polar coordinate method, follow the steps mentioned below : (Fig 1)**

Fig 1



POLAR COORDINATE METHOD

1 Command : **LIMITS** (↵)

Reset model space limits :

Specify lower left corner or [ON/OFF] <0.0000,0.0000> : (↵)

Specify upper right corner <12.0000,9.0000> : **120,90** (↵)

2 Command : **ZOOM** (↵)

Specify corner of window, enter a scale factor (nX or nXP), or [All/Center /Dynamic/Extents/Previous/Scale/ Window] <real time>: **All** (↵) regenerating model.

3 Command : **LINE** (↵)

Specify first point : **20,20** (↵)

Specify next point or [Undo]:@**80<0** (↵)

Specify next point or [Undo]:@**30<90** (↵)

Specify next point or [Close/Undo]:@**10<180** (↵)

Specify next point or [Close/Undo]:@**15<108** (↵)

Specify next point or [Close/Undo]:@**10<180** (↵)

Specify next point or [Close/Undo]:@**15<252** (↵)

Specify next point or [Close/Undo]:@**20<180** (↵)

Specify next point or [Close/Undo]:@ **14.27<90** (↵)

Specify next point or [Close/Undo]:@**20<180** (↵)

Specify next point or [Close/Undo]:@ **4.27<270** (↵)

Specify next point or [Close/Undo]:@**10.73<180** (↵)

Specify next point or [Close/Undo]: **C** (↵)

4 Save this file.

Output

— — — — — — — —

Drawing of simple conical, projection, polyconic, lambert's & UTM

Objectives: At the end of this exercise you shall be able to
- **draw simple conical projection**
- **draw polyconic projection**
- **draw lambert's and UTM.**

Requirements

Tools/Instruments

- Drawing board with drafting machine - 1 No.
- 30 cm scale - 1 No.
- Sets square (45° & 30°) - 1 Set
- Instrument box - 1 No.

Materials

- A2 drawing sheet - 1 No.
- Eraser - 1 No.
- Pencils H & HB - 1 No. each
- Cello tape - as reqd.

PROCEDURE

TASK 1: **Construct a conical projection with one standard parallel for an area bounded by 10° N to 70° N latitude and 10° E to 130° E longitudes when the scale is 1:250,000,000 and latitudinal and longitudinal interval is 10°**

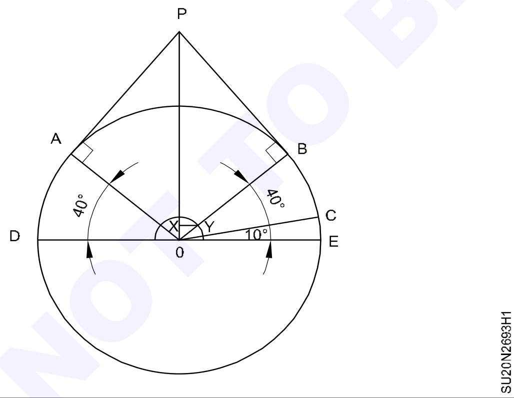
1 Radius of reduced earth R = RF x actual radius of the earth = (1/250,000,000) x 640,000,000 = 2.56cm

2 Standard parallel is 40^0 N (10, 20, 30, 40, 50, 60, 70)

3 Central meridian is 70^0 E (10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130)

4 Draw a circle of 2.56 cm radius marked with angles COE as 10° interval and angle BOE and angle AOD as 40°. (Fig 1)

Fig 1



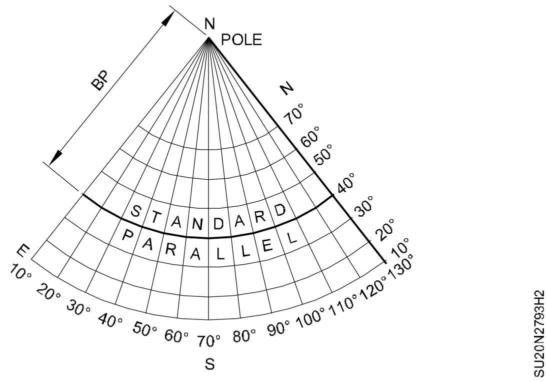
5 A tangent is extended from B to P and similarly from A to P, so that AP and BP are the two sides of the cone touching the globe and forming Standard Parallel at 40° N.

6 The arc distance CE represents the interval between parallels. Draw a circle with centre O, take CE distance as radius.

7 X-Y is the perpendicular drawn from Y the point where semicircle cut line OB. (Fig 1)

8 A separate line N-S is taken on which BP distance is drawn representing standard parallel. The line NS becomes the central meridian.(Fig 2)

Fig 2



9 Other parallels are drawn by taking arc distance CE on the central meridian.

10 The distance XY is marked on the standard parallel at 40° for drawing other meridians.

11 Straight lines are drawn by joining them with the pole.

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TASK 2: **Draw a polyconic projection for an area extending from 30°N to 75°N latitude and 45°W to 45°E longitude on a scale of 1:200000000 and projection with projection interval/class interval 15°**

1 Radius of Projection (R) = RF x actual radius of the earth = 1/200,000,000 x640,000,000= 3.2 cm.

2 Draw a circle or quadrant of radius 3.2 cm, O as centre, divide the circle with 15^0 interval lines (Angle AOB=15°, AOC = 30°, AOD=45°, AOE=60°, AOF=75°) (Fig 1(a))

3 Extend the line OA' perpendicular to OA, Draw tangent lines perpendicular to OB, OC, OD, OE, OF intersecting at the extended line of OA'.

4 Measure distance of projection interval AB, draw a small quadrant circle at O point with radius AB

5 Draw lines perpendicular to OA' at all intersecting points p-p', q-q', r-r', s-s'.

6 Draw a separate straight line representing central meridian, copy the C'D',D'E' & E'F' distance and mark on the straight line. (Fig 1(b))

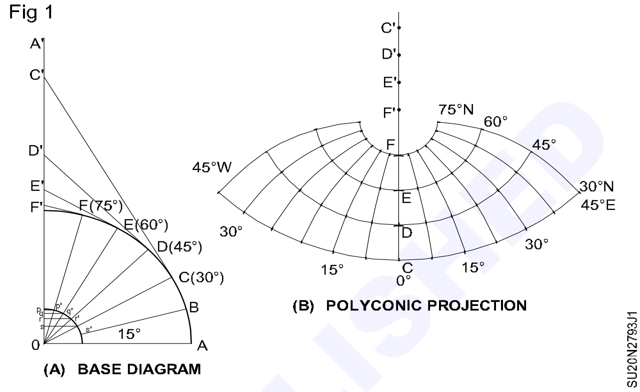
7 To draw the parallel arc lines, measure C-C' draw an arc from centre point C' on the straight line. Do the same for other parallels D-D', E-E' & F-F'.

8 Longitudinal intervals: 45^0W, 30^0W, 15^0W, 0^0, 15^0E, 30^0E, 45^0E

9 To mark the longitudinal intervals on the respective parallels take distance S-S' and mark the intervals on C (representing 30^0) curve. Do the same for the other curves with the respective angles

10 Connect all the interval marks free handly/using French curve and complete the projection

Fig 1



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TASK 3: **Construct a cylindrical equal area projection for the world when the R.F. of the map is 1:300,000,000 taking latitudinal and longitudinal interval as 15?**

1 Radius of the reduced earth = RF x actual radius of the earth = 1/300,000,000 x640,000,000= 2.1 cm.

2 Length of the equator =2πR= $2x\frac{22}{7}x2.1$ =13.2 cm.

3 Interval along the equator = (13.2 x 15°)/(360°)= 0.55 cm.

4 Draw a circle of 2.1 cm radius; Mark the angles of 15º, 30º, 45º, 60º, 75º and 90º for both, northern and southern hemispheres; (Fig 4)

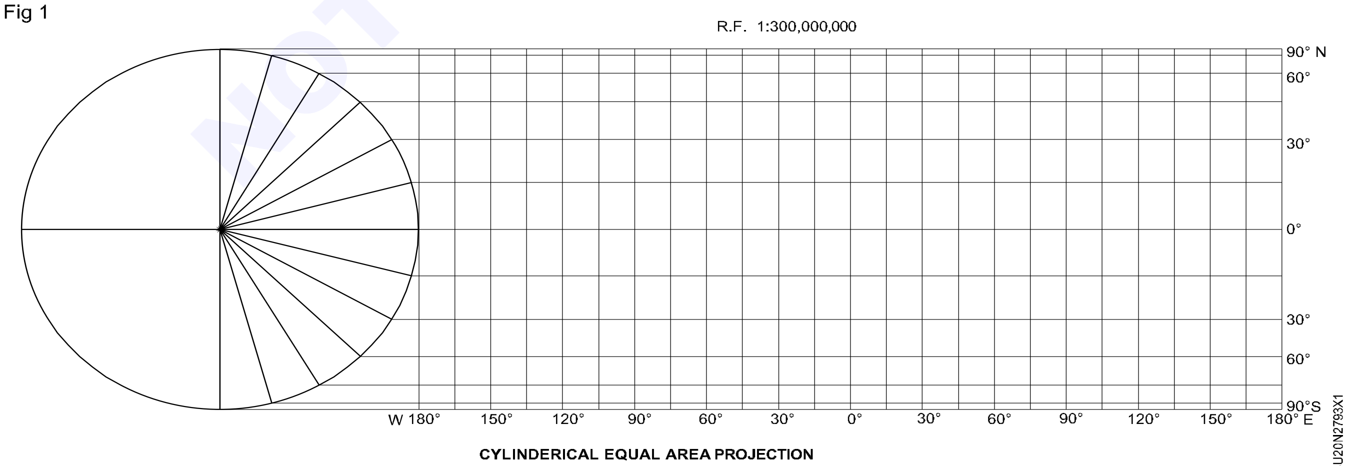
5 Draw a line of 13.2 cm and divide it into 24 equal parts at a distance of 0.55cm apart. This line represents the equator;

6 Draw a line perpendicular to the equator at the point where 0° is meeting the circumference of the circle;

7 Extend all the parallels equal to the length of the equator from the perpendicular line; and Complete the projection as shown below. (Fig 1)

Note: Instructor should guide the trainees in drawing the above test's and explain them Trainee should study the enclosed drawing and draw the each protection.

Fig 1



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Construction of UTM grid

Objectives: At the end of this exercise you shall be able to
- **construct the UTM grid.**

Requirements

Tools/Instruments

- Computer with Google Earth or other UTM software

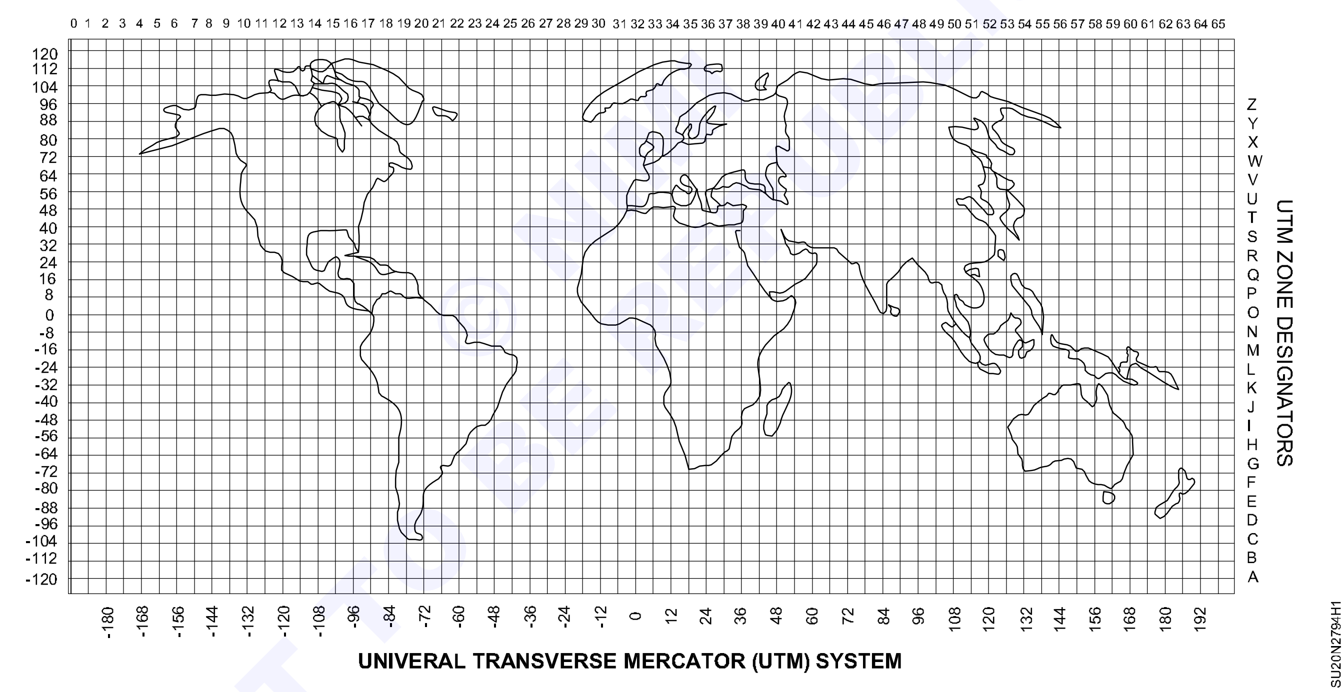
PROCEDURE

Construct the UTM grid

1 Universal transverse mercator is conformal projection.

2 Use a two dimensional cartesion co-ordinate system. (Fig 1)

Fig 1



3 Determine the UTM zone for the location you want to identify.

4 Each UTM is identified by a number from 1 to 60, based on its position relative to the prime meridians.

5 Use a UTM zone map or Google Earth to find the UTM zone for your location.

6 Divide the UTM zone into a grid of squares. Each square is 100.000m (or 100 kms) on each side. The grid is identified by a set of numbers. and letters that represent the location of the square within the UTM zone.

7 Identify the easting and northing of the location within the UTM grid.

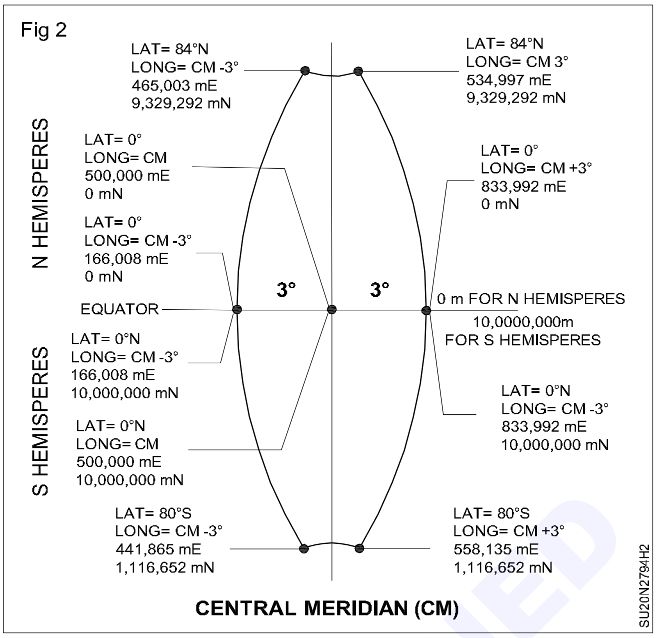
- Easting is the distance in meters from western edge of the UTM zone to the location.
- The Northing is the distance in meters from the equator to the location.

8 Use UTM grid calculator (or) online tool to determine the easting and northing for your location.

9 Combine the UTM zone, grid square identifier, easting and northing to create the UTM grid reference for the location.

10 Use secant traverse mercator projection in each zone. (Fig 2)

Fig 2



Use datum defining system 1984 (WGS 84)

Objective: At the end of this exercise you shall be able to
- **define WGS 84.**

Requirements

Tools/Instruments

- Drawing board with drafting machine - 1 No.
- 30 cm scale - 1 No.
- Sets square (45° & 30°) - 1 Set
- Instrument box - 1 No.

Materials

- A2 size drawing sheet - 1 No.
- Eraser - 1 No.
- Pencil H & 2H - 1 No. each
- Cello tape - as reqd.

PROCEDURE

Draw the defining system 1984

1 WGS84 of 1984 is a datum featuring co-ordinates that change with time. The expansion for WGS is World Geodetic System. World Geodetic System is utilized by the Branch of Defense in the U.S.

2 Draw the enclosed drawing of defining system 1984.

3 The WGS-84 co-odinate system in geometrically positioned with respect to the center of the Earth such a system is called ECEF (Earth Central Earth Fixed)

4 The WGS-84 is a three-dimensional right-handed. Cartesian coordinate system with the original coordinate point at the center of mass of an ellipsoid. (Figs 1 & 2)

Fig 1

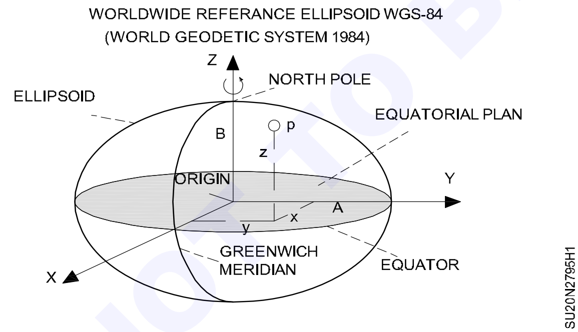


Fig 2

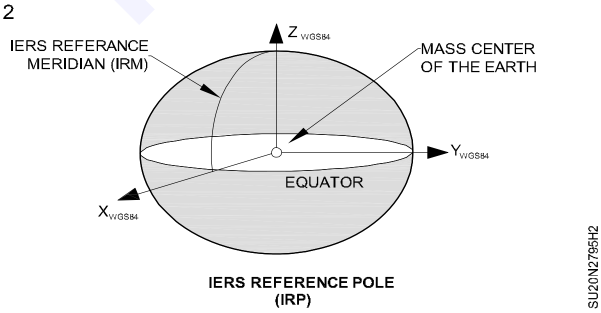
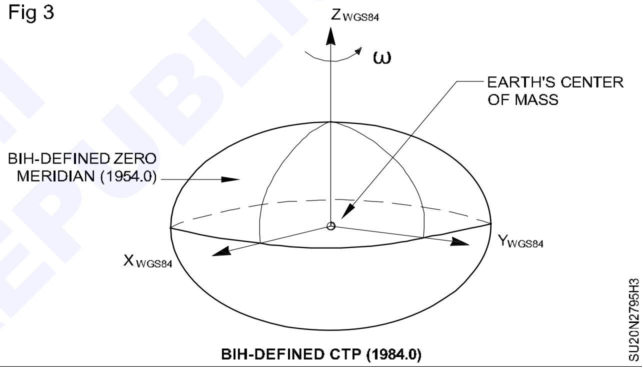


Fig 3



5 The WGS 84 meridian of zero longitude is the IERS reference meridian 102 m east of the Greenwich meridian.

6 WGS 84 datum surface is an oblate spheroid with equatorial radius = 6378137m at the equation & flattering, $f = \dfrac{1}{298.26}$

7 The Global positioning system uses WGS 84 as its reference co-ordinate.

Note: Assume suitable dimensions and take the guidance of the instructor in developing the drawing.

Unit and way point setup (co-ordinate) & Observation principal and signal structure

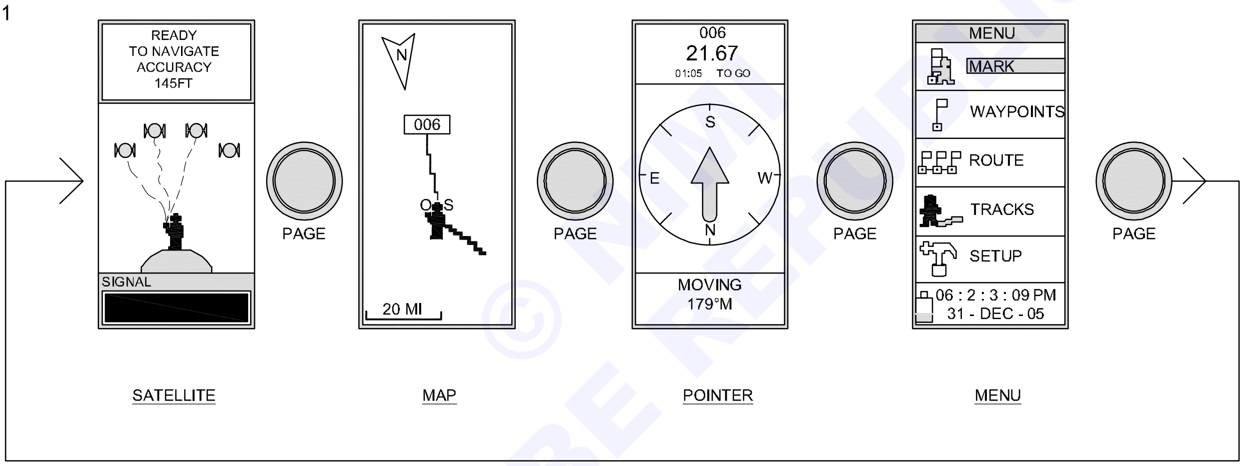
Objectives: At the end of this exercise you shall be able to
- **check the unit set up of GPS**
- **collect way points**
- **practice on saving a position (way point)**
- **practice for entering co-ordinates of location**
- **observation principle and signal structure**
- **GPS satellite signals.**

PROCEDURE

TASK 1: **Check the unit setup of GPS (Hand held)**

Press the Page button (right side of unit) several times, until you reach the Menu page. High light the word Setup and press Enter. (Fig 1)

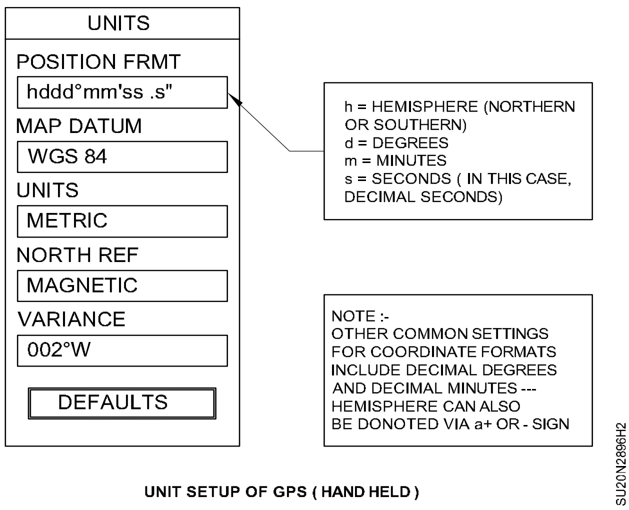
Fig 1



UNIT SETUP OF GPS (HAND HELD)

You will see the following screen. Note the settings. These are important to record as part of your data collection so that when you bring the points into GIS they can be properly displayed. A common mistake when copying data is to leave off negative sign (which denotes latitude south of the equator) or to leave off too many decimal places, if using decimal degrees or to record coordinates in degrees-minutes-seconds and then improperly convert these into decimal degrees. (Fig 2)

Fig 2



UNIT SETUP OF GPS (HAND HELD)

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TASK 2: **Collect waypoints**

- Press the Page button (right side of unit) until you reach the Menu page, as above. This time highlight the word Mark and press Enter.

You will see the following screen:

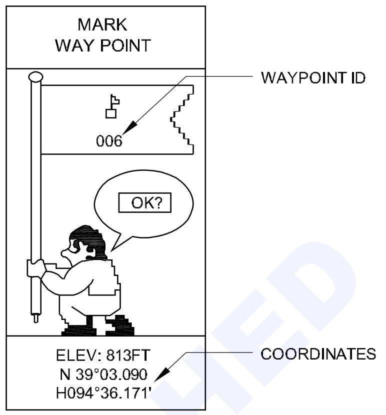
- The Waypoint ID is important to note on your survey spreadsheet or data table as this is what will link it to all information collection at that point, such as facility name or other information. (you can highlight this number by scrolling up to it press Enter if you'd like to change it) Then highlight the word OK (this is default, as shown above) and press Enter to record the point.

You can collect your data either as a series of waypoints or as a "track". (Fig 1)

- Continue to collect a series of waypoints while walking around to different locations and pressing "Enter" at each location. The Map view screen will show your progress. Pressing the Up and Down buttons will zoom and out on this screen.

- Finally, turn off the unit to save batteries. (Turning off the unit will not cause you to lose any data you have entered). Now you have a data file you'll be able to view in GIS, in the next section of this exercise.

Fig 1



COLLECT WAYPOINTS

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TASK 3: **Saving a position fix (waypoint)**

1 In any screen view, stand over the location where you want to store the coordinates.

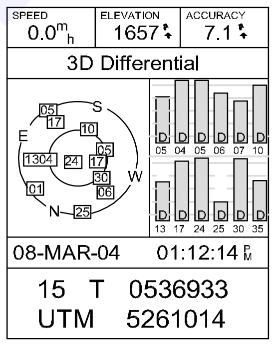
2 Allow the receiver to get a 3D Differential position fix. You will know this if you are in the "Satellite" view or when the "Accuracy" information goes below 10 feet on any of the "Navigation" screen.

3 Press and hold the <MARK> key to get the "Waypoint" screen for edits and saving.

4 You could edit the Symbol, Name, and Comment fields by following the next task.

5 With all editing complete, use the <ROCKER> key to highlight the "OK" button and then press the <ENTER> key to save your work. (Figs 1 & 2)

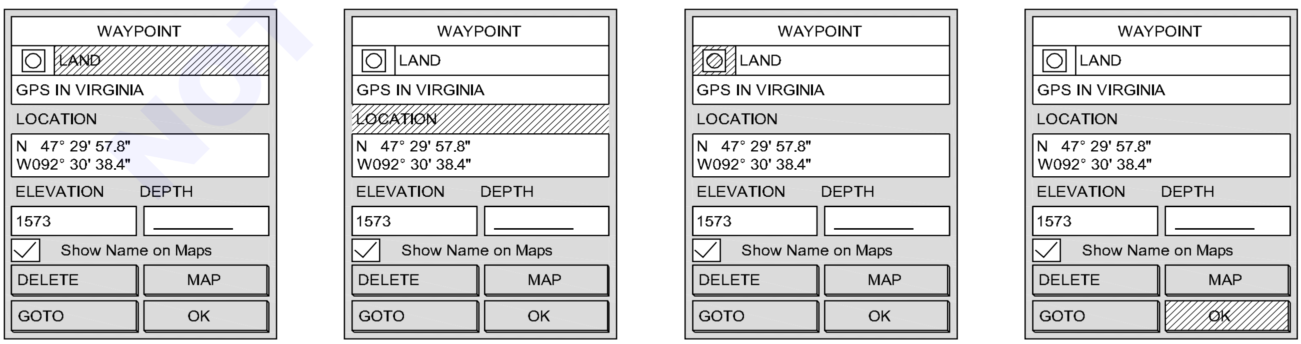
Fig 1



SAVING A POSITION FIX (WAY POINT)

SU20N2896X1

Fig 2



SAVING A POSITION FIX (WAY POINT)

SU20N2896X2

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TASK 4: **Entering coordinates of location you are given**

1 You will receive coordinates of plot location.

2 Turn on the receiver and press the <ENTER> key until you are at the 'Satellite View' screen.

3 If we are in the workshop/lab, we must start the simulator. Otherwise skip to step 5.

4 Press the <MENU> key. Highlight 'Start Simulator' and press <ENTER> to accept.

5 As you have used the receiver you may have noticed the word "Mark Key" just underneath the <ENTER> key. This key serves both functions.

6 With you, receiver in any screen view, press and hold the <MARK> key.

7 You will be taken to the "Mark Waypoint" screen for edits and saving.

8 Use the <ROCKER> key to highlight the Location coordinate display.

9 To edit this Location coordinate, press the <ENTER> key.

10 Using the <ROCKER> key, arrow to the right until the first digit that needs to be changed is highlighted. Do not change the "N" as this tells the unit this coordinate is north of the Equator. Pressing the <ROCKER> key up or down moves though the alphabet, numbers, and special symbols in sequence.

11 Arrow right and continue to update the coordinate in the box.

12 Once the Latitude is done, continue with arrow right to reach the Longitude numbers and edit those numbers as needed. Do not change the "W" or the "0" as these are required fields for North America.

13 When the coordinate in the field is correct press the <ENTER> key once and the entire box is then highlighted.

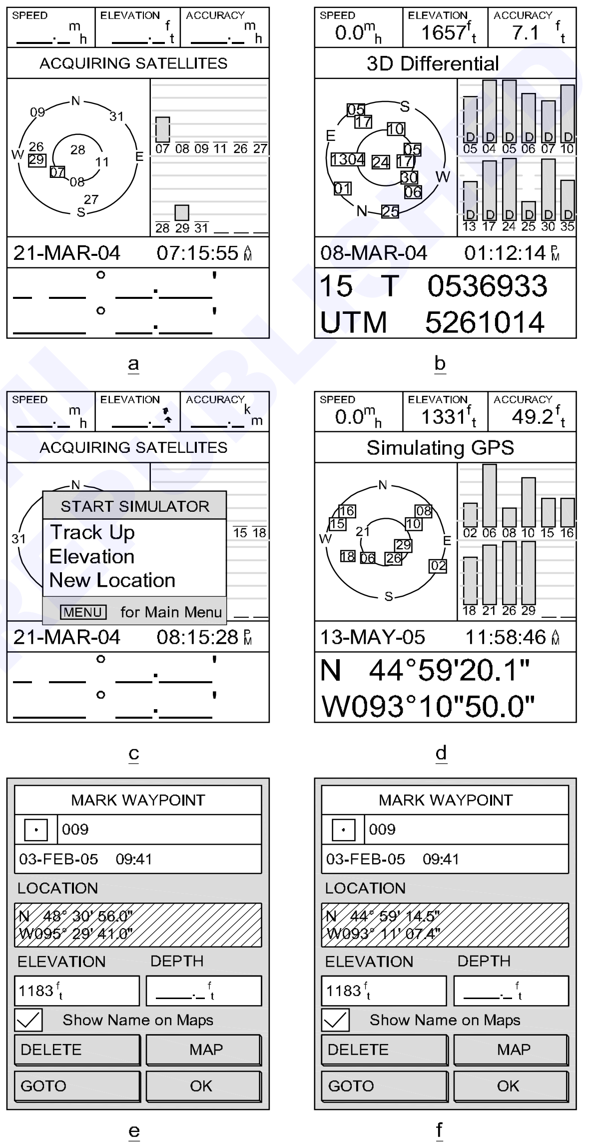
14 You can edit the information in any other field by highlighting them using the <ROCKER> key and then pressing the <ENTER> key while the field is highlighted. You can change the point's name, comments, map symbol or the elevation.

15 You should always give a point a meaningful name because after a while you will forget what number given for the feature. The comments are also helpful to further overcome the ten (10) character name limit. There is a sixteen (16) character limit for the comment field.

16 With the symbol box highlighted, you can choose from any symbol in the dropdown list using the <ROCKER> key. Changing the symbol is not as important as creating a unique and meaningful name but it can be helpful on a crowded map. The highlighted symbol is selected while you press the <ENTER> key.

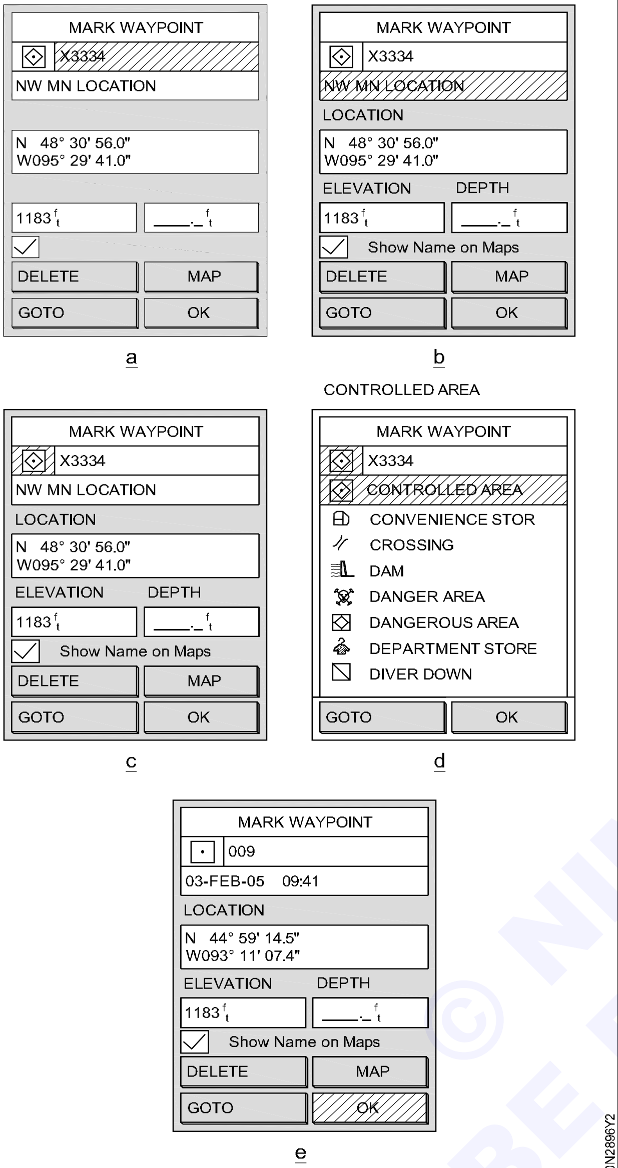
17 When complete, highlight the "OK" button and press the <ENTER> key to save all of your changes. (Figs 1 & 2)

Fig 1



ENTERING COORDINATES OF LOCATION

Fig 2



ENTERING COORDINATES OF LOCATION

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TASK 5: **Observation principle and signal structure**

- GPS is a one-way ranging system i.e. signals are only transmitted by the satellite. Signal travel time between the satellite and the receiver is observed and the range distance is calculated through the knowledge of signal propagation velocity. One way ranging means that a clock reading at the transmitted antenna is compared with a clock reading at the receiver antenna. But since the two clocks are not strictly synchronized, the observed signal travel time is biased with systematic synchronization error. Biased ranges are known as pseudoranges. Simultaneous observations of four pseudoranges are necessary to determine X, Y, Z coordinates of user antenna and clock bias.

- Real time positioning through GPS signals is possible by modulating carrier frequency with Pseudohandom Noise (PRN) codes. These are sequence of binary values (zeros and ones or +1 and -1) having random character but identifiable distinctly. Thus pseudoranges are derived from travel time of an identified PRN signal code. Two different codes viz. P-code and C/A code are in use. P means precision or protected and C/A means clear/acquisition or coarse acquisition.

- P- code has a frequency of 10.23 MHz. This refers to a sequence of 10.23 million binary digits or chips per second. This frequency is also referred to as the chipping rate of P-code. Wavelength corresponding to one chip is 29.30m. The P-code sequence is extremely long and repeats only after 266 days. Portions of seven days each are assigned to the various satellites. As a consequence, all satellite can transmit on the same frequency and can be identified by their unique one-week segment. This technique is also called as Code Division Multiple Access (CDMA). P-code is the primary code for navigation and is available on carrier frequencies L1 and L2.
- The C/A code has a length of only one millisecond; its chipping rate is 1.023 MHz with corresponding wavelength of 300 meters. C/A code is only transmitted on L1 carrier.
- GPS receiver normally has a copy of the code sequence for determining the signal propagation time. This code sequence is phase-shifted in time step- by-step and correlated with the received code signal until maximum correlation is achieved. The necessary phase-shift in the two sequences of codes is a measure of the signal travel time between the satellite and the receiver antennas. This technique can be explained as code phase observation.
- For precise geodetic applications, the pseudoranges should be derived from phase measurements on the carrier signals because of much higher resolution. Problems of ambiguity determination are vital for such observations.
- The third type of signal transmitted from a GPS satellite is the broadcast message sent at a rather slow rate of 50 bits per second (50 bps) and repeated every 30 seconds. Chip sequence of P-code and C/A code are separately combined with the stream of message bit by binary addition ie., the same value for code and message chip gives 0 and different values result in 1.
- The main features of all three signal types used in GPS observation viz carrier, code and data signals are given in Table 1.

Table 1

GPS Satellite Signals

Atomic clock (G, Rb) fundamental	**10.23.MHz**
L1 Carrier signal	154 x 10.23 MHz
L1 Frequency	1575.42 MHz
L1 Wave length	19.05 Cm
L2 Carrier signal	120 x 10.23 MHz
L2 Frequency	1227.60 MHz
L2 Wave length	24.45 Cm
P-code frequency (Chipping rate)	10.23 MHz (Mbps)
P-code wave length	29.31 M
P-code period	267 days
C/A-code frequency (Chipping rate)	1.023 MHz (Mbps)
C/A-code wave length	293.1 M
C/A-code cycle length	1 Milli second
Data signal frequency	50 bps
Data signal cycle length	30 seconds

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TASK 2: **GPS satellite signals**

The signal structure permits both the phase and the phase shift (Doppler effect) to be measured along with the direct signal propagation. The necessary bandwidth is achieved by phase modulation of the PRN code.

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Familiarisation with hand held GPS & Importing data from GPS devices to computer

Objectives: At the end of this exercise you shall be able to
- **identify the safety warning**
- **practice with hand held GPS**
- **carryout satellites location**
- **operate to data from GPS devices**
- **identify viewing real time information**
- **identify viewing time line.**

Safety warning

Use care: The Global Positioning System (GPS) is operated by the U.S. Governement, which is solely responsible for the accuracy and maintenance of the GPS network. The accuracy of position fixes can be affected by the periodic adjustments to GPS satellites made by the U.S. government and is object to change in accordance with the Department of Defence GPS user policy and the Federal Radio navigation Plan. Accuracy can also be affected by poor satellite geometry and obstructions, like buildings and large trees.

Federal communication commission interference statement: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment can generates, uses and can radiate radio frequency energy so, if it is not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. The equipment does cause harmful interference to radio or television reception, can be determined by turning the equipment off and on.

Introduction to GPS: GPS stands for "Global Positioning System". It refers to a collection of 24 satellites placed in orbit all around the earth with very precise clocks on board. By locating the signals from at least 4 of these satellites at a point on the earth using a GPS receiving unit, you can pinpoint your exact location at any given time.

PROCEDURE

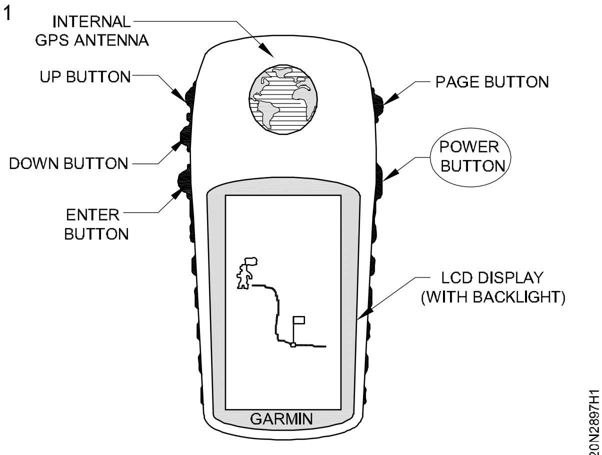
TASK 1: **Familiarize yourself with Hand held unit and turn it on. (Example - eTrex)**

(If you are using a GPS unit other than the Garmin, eTrex legend, consult your user's manual to follow these general steps).

e-Trex description

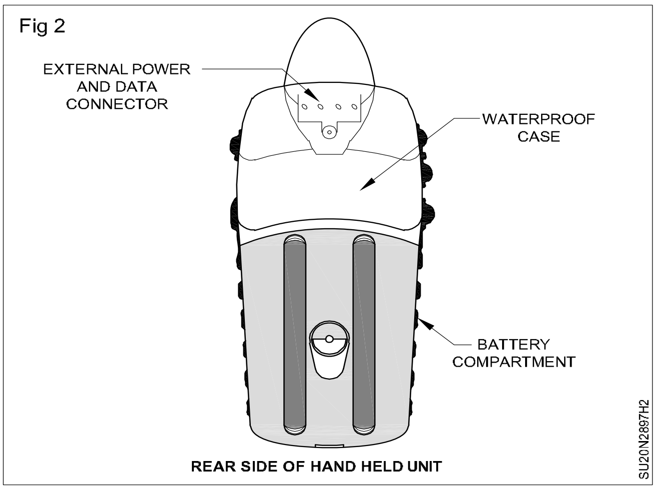
- The Up and Down buttons on the left will allow you to select options on pages and menus, adjust the display contrast, zoom in and out on the Map Page and cycle through data on the Pointer Page. (Fig 1)
- The Enter button will confirm data entry and menu selections. Pressing and holding this button activates the Mark Waypoint Page.
- The Page button will switch between pages and back you out of pages. If you start to do something and don't want to continue, you can stop by pressing this button.
- The Garmin eTrex vista handheld mapping GPS provides all the navigation tools you will need. This GPS comes packed with important travelling features.
- The Antenna should be kept unobstructed at all times in order to receive a clear signal from as many satellites as possible. It is best to hold the unit at chest-height, out in front of you so that your body does not block the signals. (Fig 2)

Fig 1



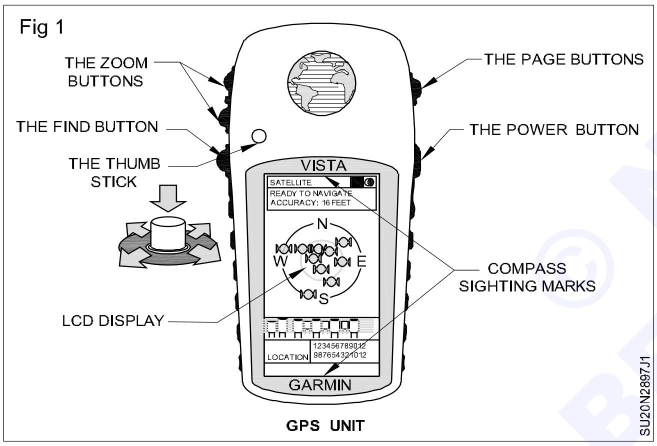
HAND HELD UNIT

- The unit requires 2 AA batteries to operate. A data cable will be needed in order to transfer data to a computer after collection.



TASK 2: **Explore your GPS unit**

This exercise is designed to ensure that a user has a working understanding of a handheld GPS unit. Steps in this exercise include turning the unit on/off, navigating through the system menus and understanding the different screens on your GPS. This exercise was designed around a Garmin Vista. (Fig 1)



If you are not using this type of unit then the following may not be exactly the same for you, however it should be fundamentally similar. Use the directions that come with your personal GPS unit to complete this part of the exercise if needed.

The figure shown here a description of what the different Garmin Vista buttons do. Turn the unit on by pressing and holding the POWER button (you must be outdoors in a clear area for this to work properly). The GPS will default to the Satellite screen after a copyright screen and a warning message. The first time the GPS unit is turned on it may take 5 minutes to establish a position. You can navigate back and forth between different screens using the 'PAGE' and 'QUIT' buttons. An illustration of the different screens is shown in the graphic below.

The **satellite screen** shows the position and name of satellites currently being tracked (and relative satellite signal strength).

The **map screen** shows you a map of where you are with respect to other mapped features. Your unit may or may not have anything in map view while you first turn on your instrument. If you have zoom keys (in/out) you can use them here to change the scale of your map.

The **navigation page** displays your current position in selected coordinates, as well as your speed and direction, elevation and the current time.

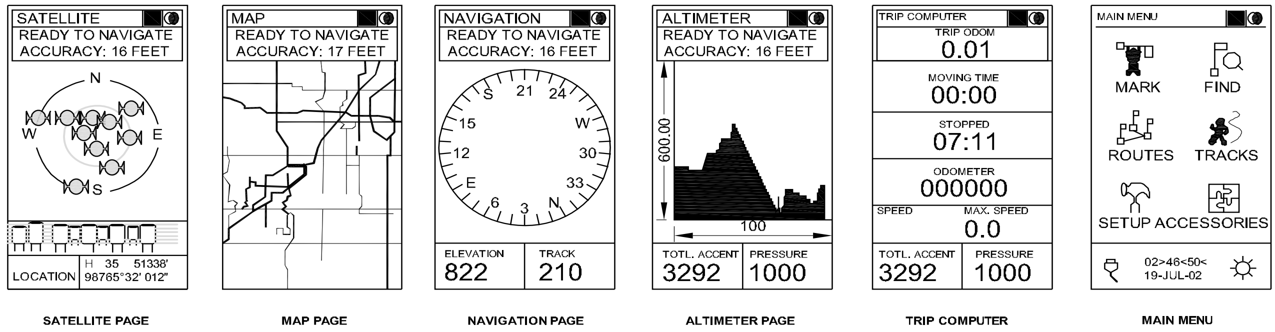
The **altimeter page** tells your speed and direction. You can use the compass screen to direct you back to a previously marked point (illustrated at the top of the graphic). (Fig 2)

The main menu is where you go to mark and manage waypoints, routes and to make changes in the configuration of your GPS (such as change the language or coordinate system).

Locate satellites

- Press the On button (on the right side of the unit). The unit will start to look for satellites and will display the satellite acquisition page. This process normally takes several minutes, so be patient. (The satellite signals do not go through walls, so this cannot be done from inside a building). (Fig 1)
- For more detail on which satellites have been located, press the Enter button (on the left of your unit) and choose Advanced Sky view: (Fig 2)
- This page will provide more information about the position of the satellites in the sky and each one's signal strength. It can help you identify possible obstacles blocking the signal (such as buildings, trees, mountains, etc.) Preferably the satellites locations will be a mix of high and low on the horizon, in several different directions. (Figs 3 to 5)
- Once enough satellites have been located, the unit will say "Ready to Navigate" and provide an estimate of accuracy. The exact number is not crucial, just know that it can be influenced by a number of factors,

Fig 2



GPS UNIT

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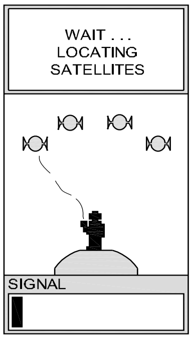
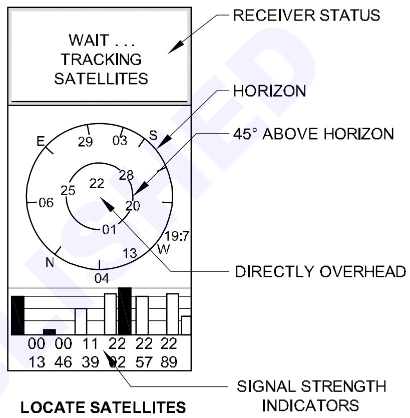
Fig 3



LOCATE SATELLITES

SU20N2897J3

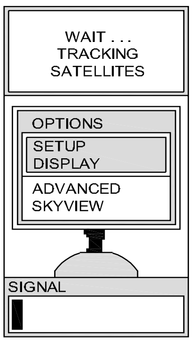
Fig 5



LOCATE SATELLITES

SU20N2897J5

Fig 4



LOCATE SATELLITES

SU20N2897J4

TASK 3: **Import data from GPS devices**

If you have a GPS (Global Positioning System) device you can connect it to your computer to import your waypoint and track data in Google Earth. This will allow you to view your GPS data in Google Earth.

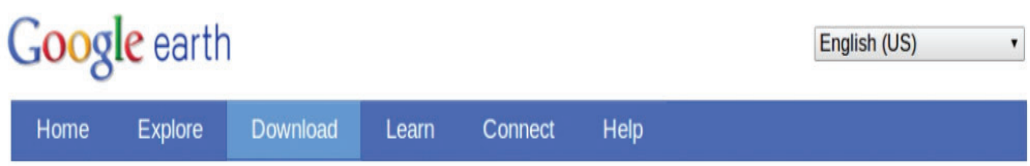
Download google earth: Update to the latest version of Google Earth in Google Earth is a freely available virtual globe program. It displays satellite images, aerical photographs, and graphic layers on personal computers by delivering them over the Internet.

1 Click go the Google Earth download page.

2 Click the **Agree** and **Download** button. Your browser will display a **Thank You** page while Google Earth automatically downloads in the backgound.

3 At the end of the download, an alert box will tell you that the dmg (Mac) or. ex (PC) file contains an application. Click the continue (Mac) or Save (PC) button to finish the download. (Figs1, 2 & 3)

Fig 1



GOOGLE EARTH

SU20N2897M1

Fig 2

GOOGLE EARTH

SU20N2897M2

Fig 3

GOOGLE EARTH

SU20N2897M3

TASK 4: **Launch Google Earth**

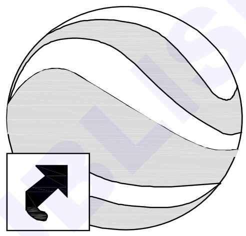
You much have a live internet connection while using Google Earth. As you move the cursor around zoom in and out, new images are downloaded to your computer from Google's servers.

1 Launch Google Earth by double-clicking the Google Earth icon on your desktop or clicking its icon in your start menu (PC) or Dock (Mac).

2 You should now see the main Google Earth window.

3 Explore its features including zooming in and out, panning, and turning layers on and off. (Figs 1, 2 & 3)

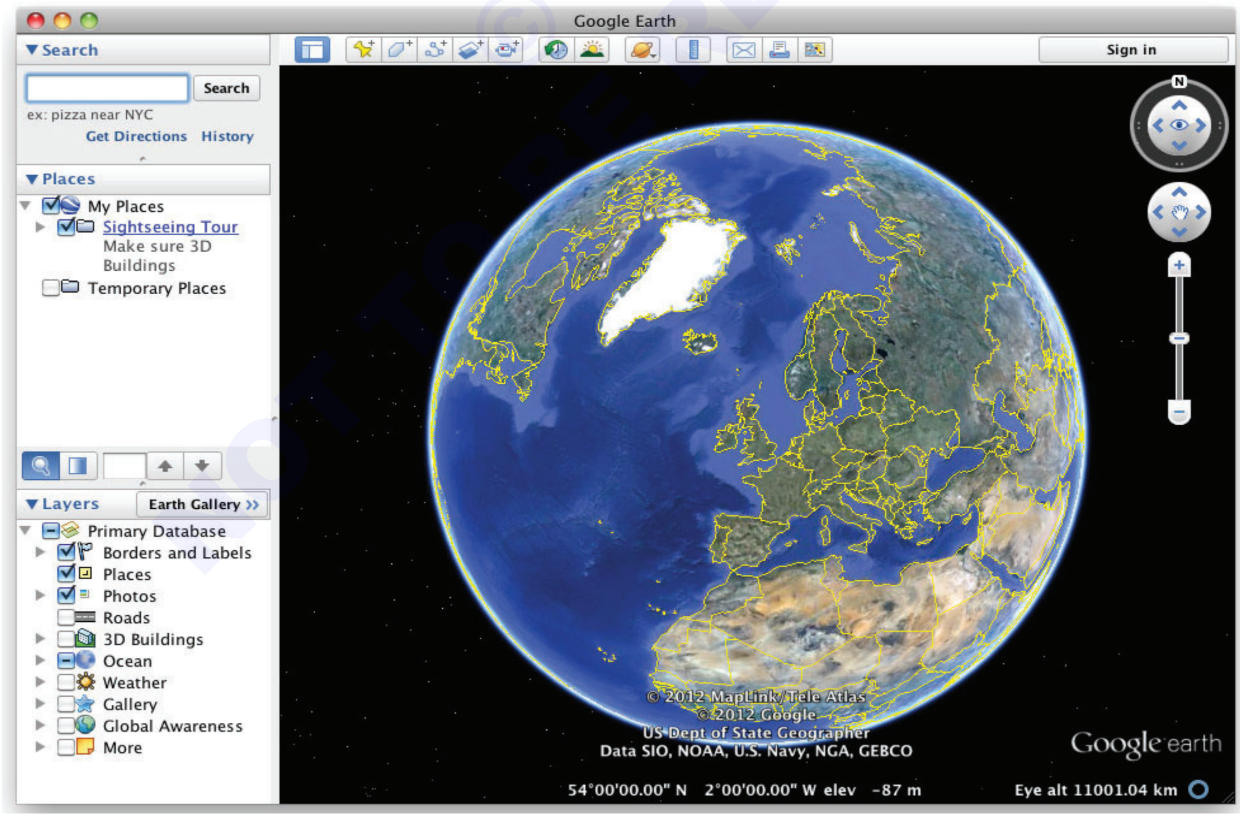
Fig 1



GOOGLE EARTH

SU20N2897N1

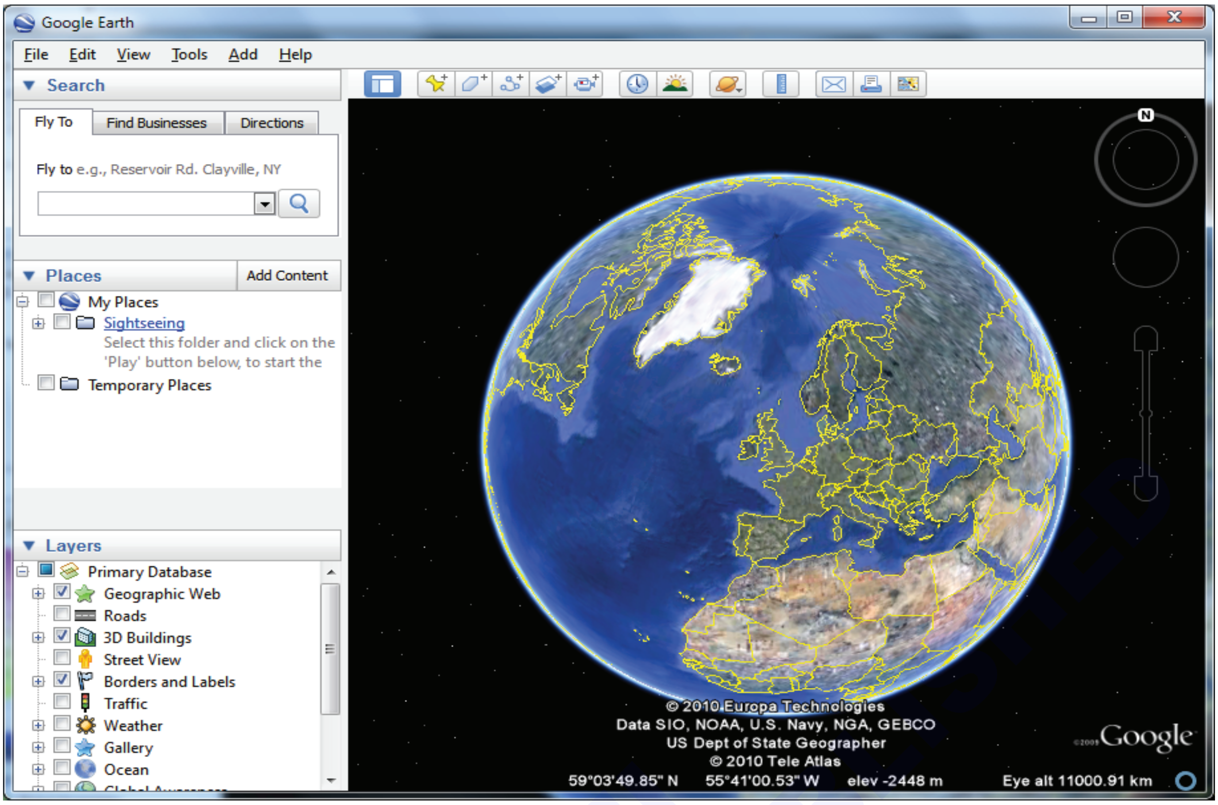
Fig 2



GOOGLE EARTH

SU20N2897N2

Fig 3

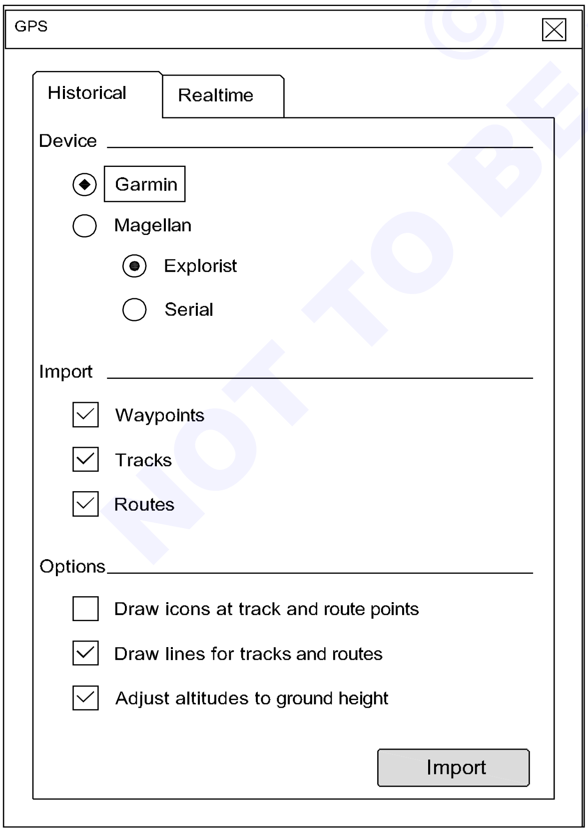


GOOGLE EARTH

SU20N2897N3

TASK 5: **Importing GPS data (Fig 1)**

Fig 1



GPS

SU20N2897X1

About GPS points

Tracks - Tracks (or track points) are points that are automatically recorded by your GPS device as you travel.

Way points - Waypoints are points entered by the user. Waypoints are typically marked with a name, such as "home" or "turn around point".

Routes - Route points are used by the GPS device to create a route from one recorded point to another recorded point. Route points can contain multiple sets of directions and can be imported into Google Earth as paths.

Steps

1 If you are using a Garmin USB device and a Windows computer, please install the Garmin USB driver from the CD that came with your GPS device or download this driver from the Garmin website.

2 Connect your device to the computer running Google Earth with the help of social cable or USB cable.

3 Turn on the GPS device.

4 From the Tools menu, select GPS. The GPS window appears.

5 Select the correct manufacturer type for your device.

6 Under import, select the types of data you want to import.

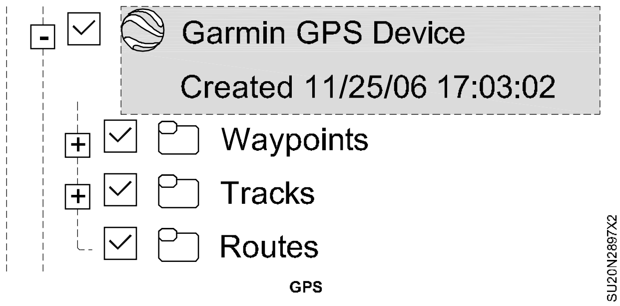
7 Under options, choose you drawing preferences. Check draw icons at tract and route points if you want an icon to be displayed in the 3D viewer for every track/route point recorded by your GPS device. Check draw lines for tracks and routes to draw each GPS track and route as a solid line.

8 Check the adjust altitude to ground height check box to adjust all recorded point to ground level, such as when importing a track taken on foot, car or bike. However, if your GPS track was recorded while hang gliding or flying, make sure this option is not selected so that your points will appear as above-ground points.

9 Click OK. When your GPS data is finished loading into Google Earth, a conformation dialog box appears.

Your data appears in the places panel with the label Garmin GPS device or Magellan GPS device, depending upon the device used (see supported devices) if you expand that folder, you can see the data sorted into the appropriate folders depending upon the type of data, as illustrated in the example below. (Fig 2)

Fig 2



GPS

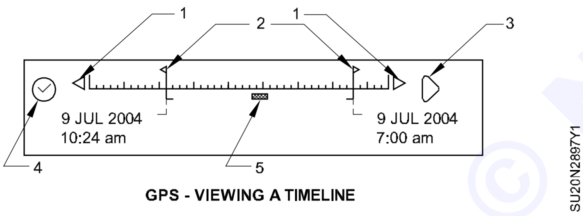
You can expand those folders and explore the information within. This includes organizing, editing, sharing,saving and more.

If you receive a connection error; turn off the GPS device, turn it on again and start again from step 3 above.

— — — — — — — —

TASK 6: **Viewing real time GPS information (Fig 11)**

Fig 1



GPS - VIEWING A TIMELINE

If you have connected your portable computer to a GPS device, you can view GPS information in realtime.

1 Connected you GPS device and portable computer as described in steps 1-4 of importing GPS data.

2 In the GPS dialog box, click the real time tab.

3 Choose the appropriate options:

- Select protocol - NMEA.
- Track point import limit - This is the maximum number of points imported per poll of the device. A smaller number can result in faster data but give less accurate depiction of your journey, while a large number can mean the opposite.
- Polling interval (seconds) - This is the frequency of which Google Earth collects data from the GPS device.
- Automatically follow the path-check this have the 3D viewer center to follow the current real time GPS track.

4 Click start to begin real time GPS tracking.

— — — — — — — —

Data collection on DGPS mode

Objectives: At the end of this exercise you shall be able to
- **differential GPS (DGPS)**
- **calculated the difference between the GPS.**

PROCEDURE

Working of DGPS

- Reference receiver is placed on known point
- Reference receiver is switched on and begins to track the satellites
- It can calculate position from getting the signals from the satellite
- The reference receiver is having the exact value of the position that is already fed into it manually
- So reference receiver will have two values, one is computed value by tracking the satellite signals and the second the actual value of position fed into it
- Now the receiver can estimate very precisely the ranges to the various satellite with the help of actual position value fed into it
- Reference receiver is connected with rover receiver by a radio data link
- Rover receiver calculate ranges to the satellites and then it applies the corrections received from the reference receiver through the radio data
- This let it to calculate more accurate position
- Using this techniques all of the error sources are minimized hence a more accurate position is achieved

Process of GPS data in software

Objectives: At the end of this exercise you shall be able to
- **processing of GPS data in software.**

Requirements

Tools/Instruments

- Computer with software

PROCEDURE

Process of GPS data in software (Figs 1 to 4)

- After the receiver has collected the field data, the receivers are connected to the computer using a data downloading cable(RS232) and the data is downloaded into the computer for post processing with the help of downloading software provided with each instrument
- For control point establishment we have to take one reference station to be placed on the control point we have to take the data. On that point data will be processed with respect to some stations spread all over the world for the point to find out the location of point objects.
- We had collected the data by using stop and go method, then with respect to the reference station those location will be processed and find out using the GPS software.
- And for line object again with respect to reference station that rover data will be processed and that has been found through GPS processing.
- For the GPS data processing take up, the GNSS solution as our processing software to start with first create a new project and take what all the default settings are there except miscellaneous. Under miscellaneous, we take this VRS maximum range as 3000 kilometers.

Fig 1

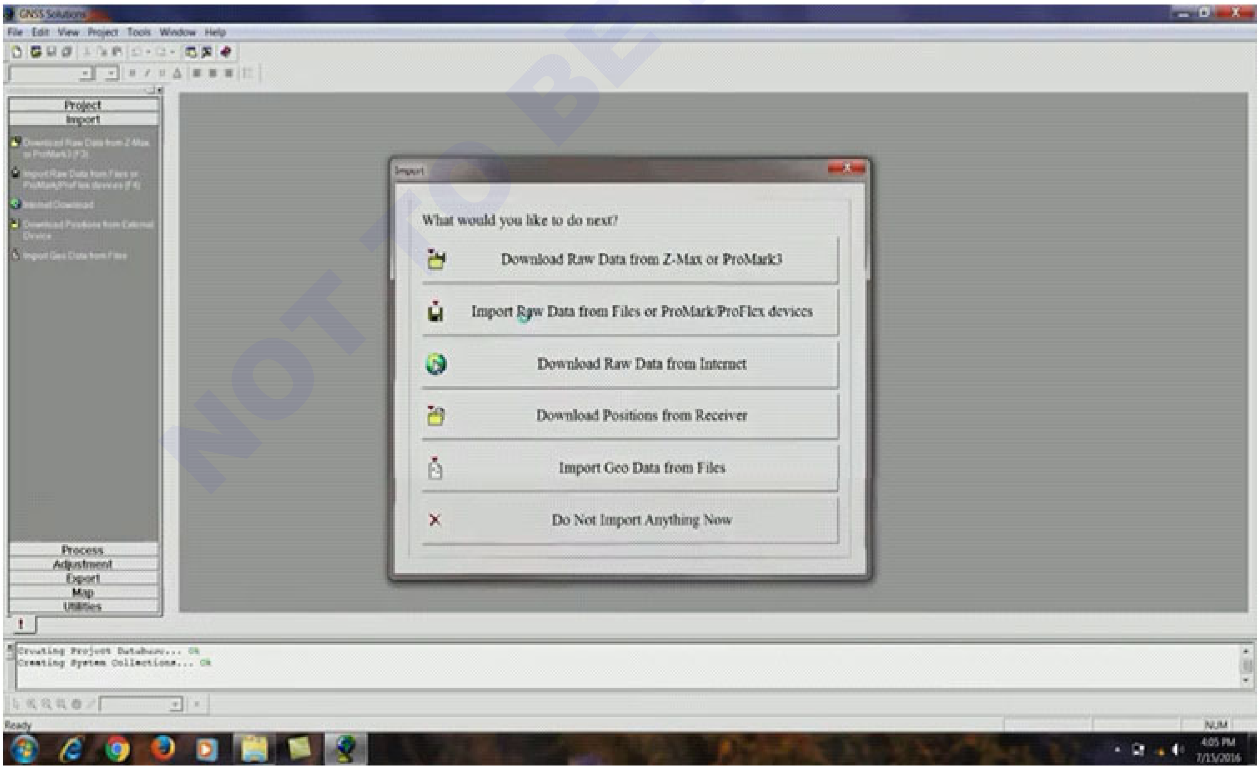
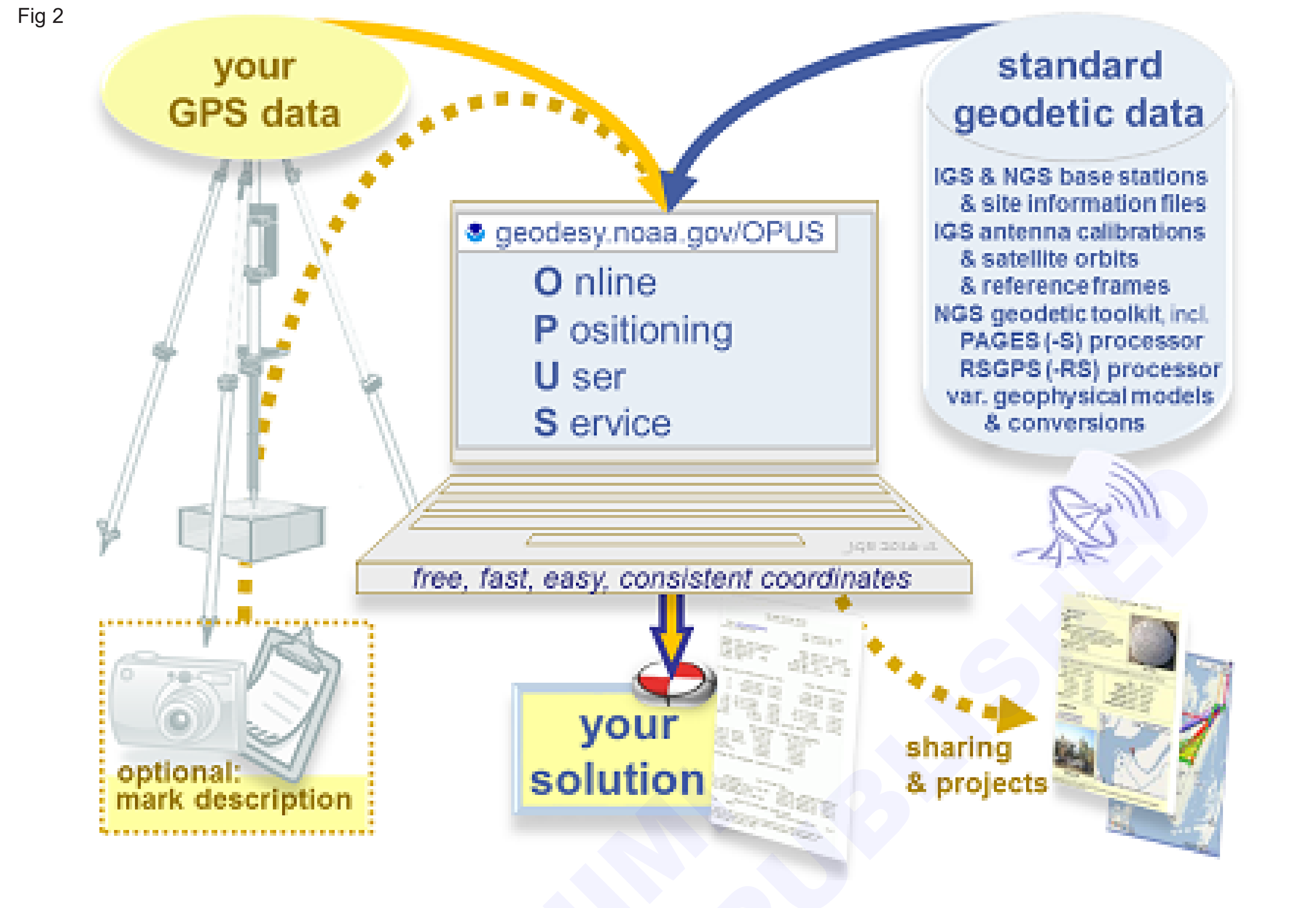


Fig 2


your
GPS data
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geodetic data
IGS & NGS base stations
& site information files
IGS antenna calibrations
& satellite orbits
& reference frames
NGS geodetic toolkit, incl.
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sharing
& projects

Fig 3

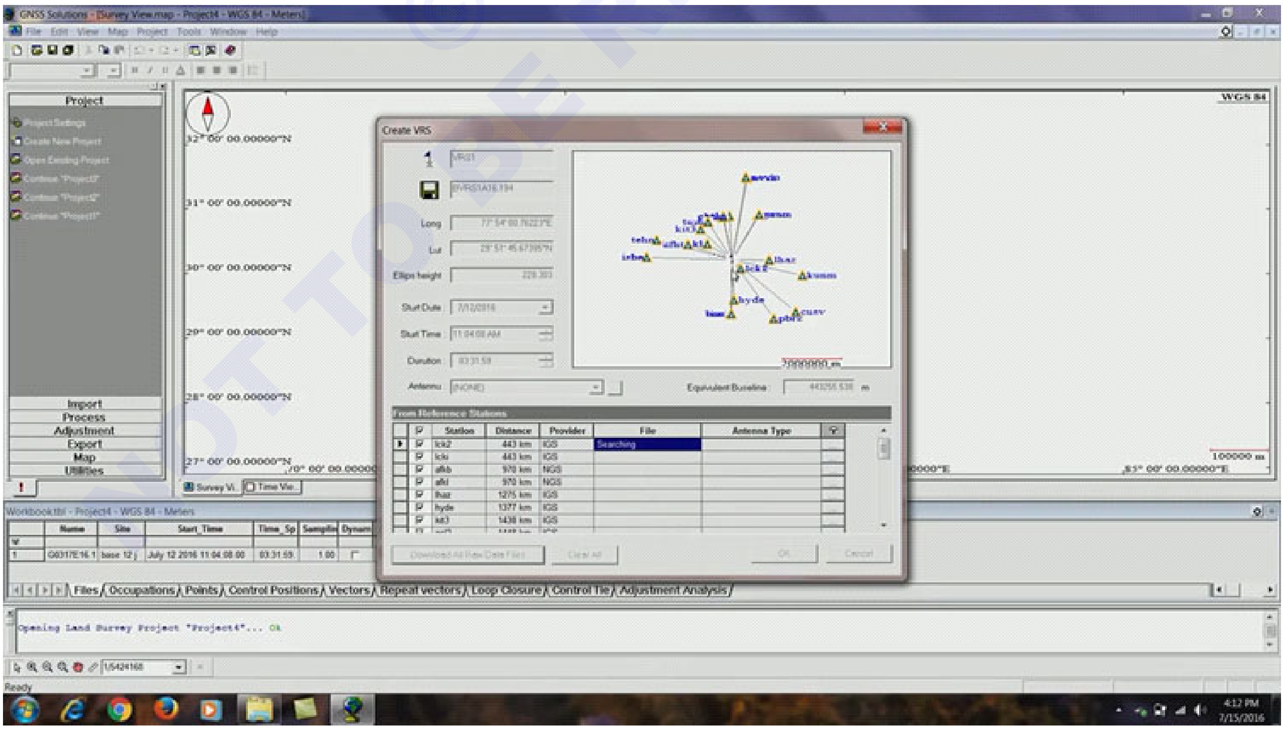
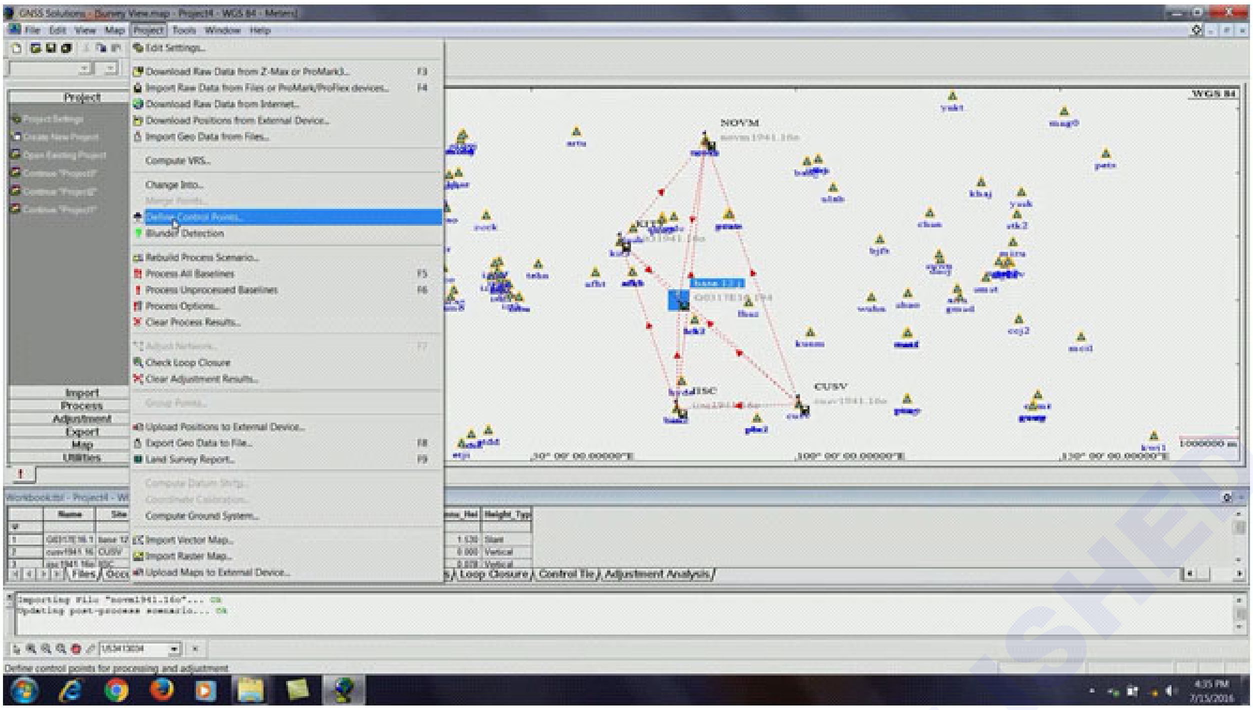

Create VRS
Files Occupations Points Control Positions Vectors Repeat vectors Loop Closure Control Tie Adjustment Analysis

Fig 4



- Import the data which we have collected in the field, and that data has already been transferred to this office computer; import the data to this project work. This is the base data.
- Download data files of these stations particularly in which stations the observations are available for the day on which the data for this station has been collected during this time - start time and duration.
- The software will check checking whether these stations have the data for this date. During these hours, select the stations provide a good closed network.
- Now you can see that this will form a good network of triangle and, so select these four stations as our reference data to get the location of this station.
- Now this is the network of triangle. Go to project – define control points. Actually the latitude, longitude and height whichever is available here is actually form the data.
- Now we can process all baseline. After processing the stations as baseline we will get the location of the reference station and for our further work we will be using that position of the reference station as our known point.

Plotting the contour lines with the help of Auto Civil/Civil 3D software/Any other software

Objective: At the end of this exercise you shall be able to
- **plotting the contour lines with the help of Auto Civil/Civil 3D software.**

Requirements

Tools/Instruments

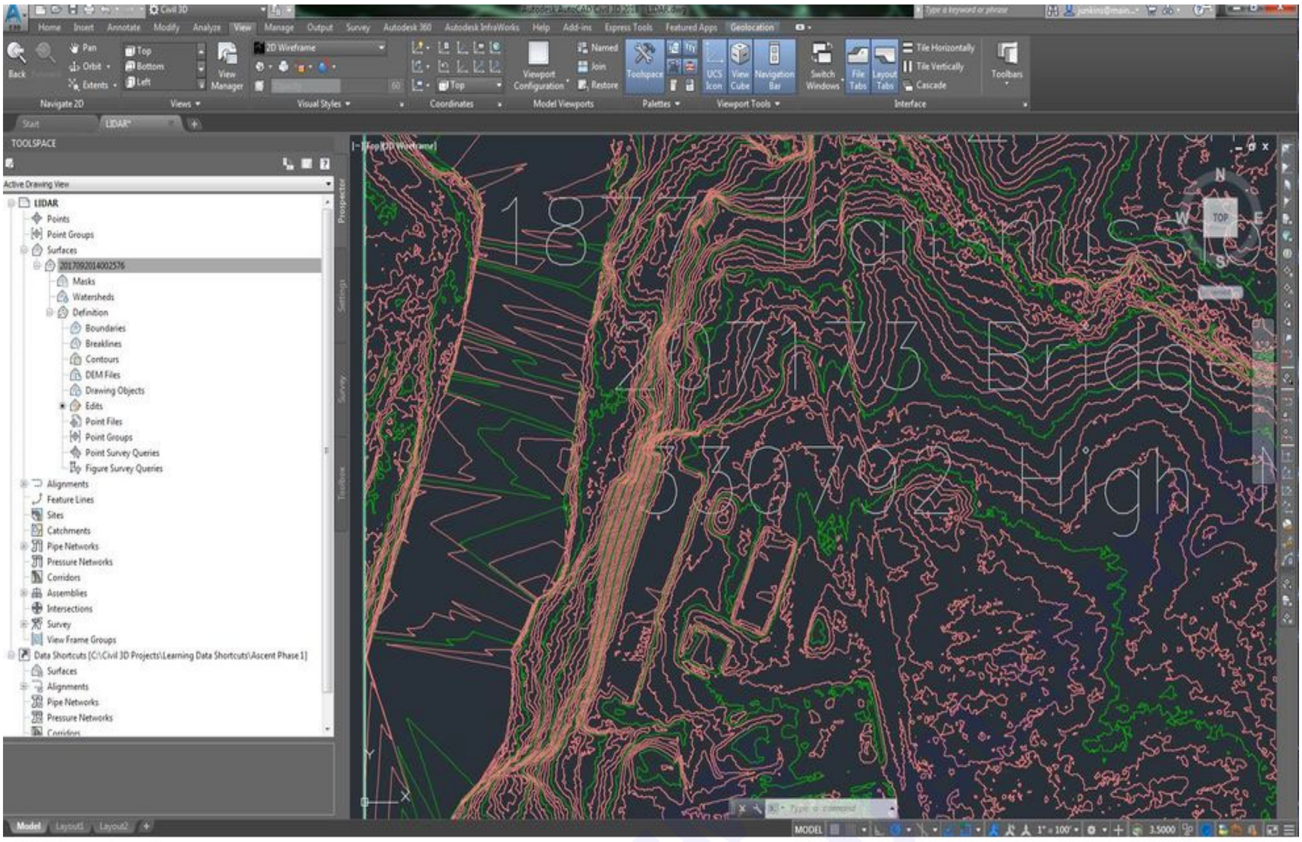
- Computer with required Software and Hardware

PROCEDURE

Plotting the contour lines (Figs 1 to 8)

- Open Notepad from the computer, copy all the input points in required arrangements and save in a seperate folder as .txt format
- Open Autodesk Civil 3D software, open toolspace from home tab, click to expand Open drawings – drawing1 – Points – Create. Create points window will appear, select import
- At import points window click add file then open the .txt file we saved earlier specify the point file format and click OK
- You can see them they are arranged in the way they will follow maybe the way that we are placed on the edge/contour surface.
- To create the surface click Surface from toolspace enter the information like name & description click OK
- And then click to expand Surface – CONTOURS – Definition – Point group – Add, at the Point groups window select All points, click apply and then OK
- You can see the surface is created. Click the point group and go to point group properties, you can toggle different point style and add point style ex: select elevation only, then click apply and OK
- Go to Marker tab adjust the marker style and size, now you can see all the contour lines and elevation with the specified values.

Fig 1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Contours
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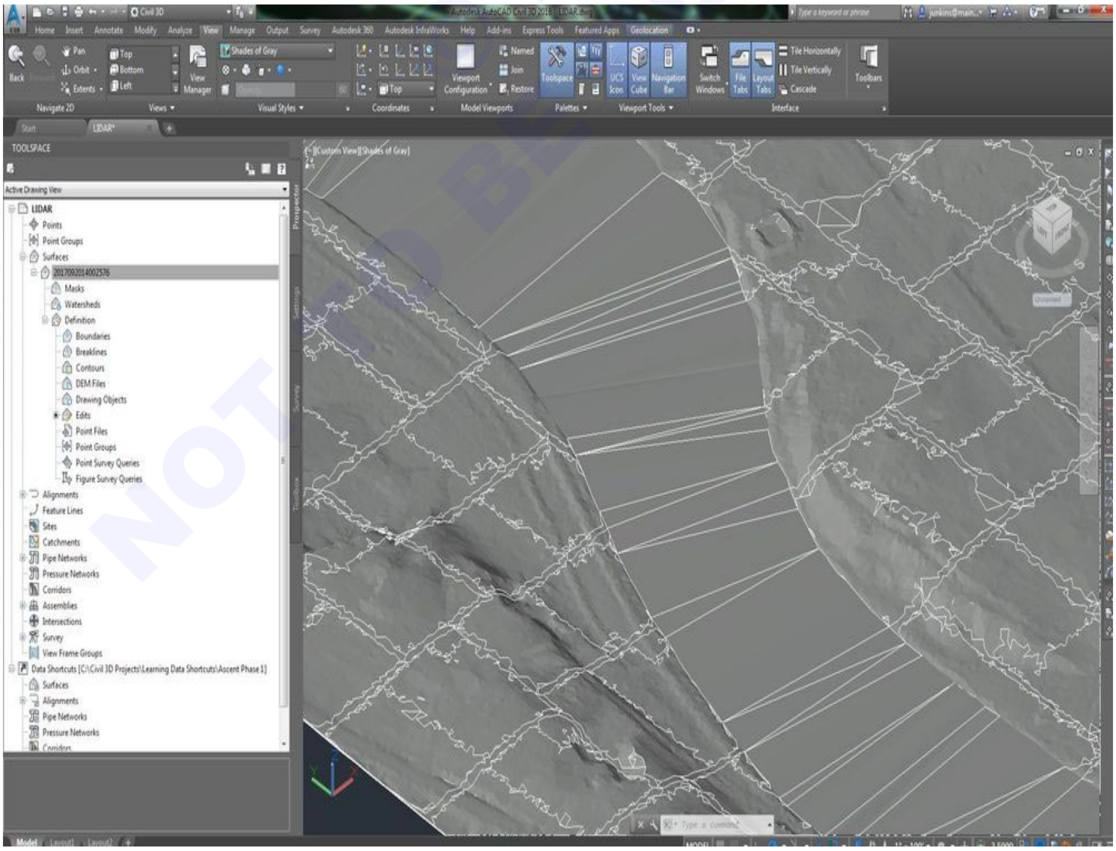
Drawing Objects
Edits
Point Files
Point Groups
Point Survey Queries
Figure Survey Queries
Alignments
Feature Lines
Sites
Catchments
Pipe Networks
Pressure Networks
Corridors
Assemblies
Intersections
Survey
View Frame Groups
Surfaces
Alignments
Pipe Networks
Pressure Networks

Fig 2


TOOLSPACE
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Pressure Networks

Fig 3

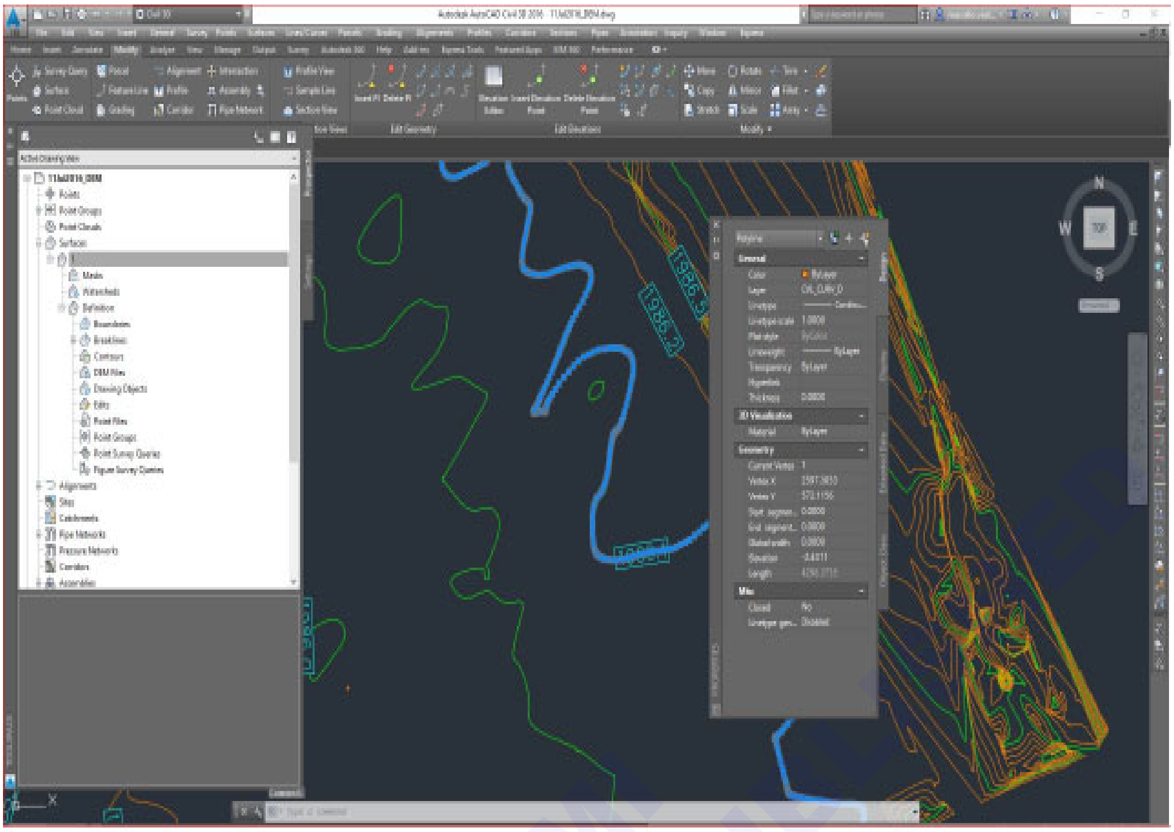


Fig 4

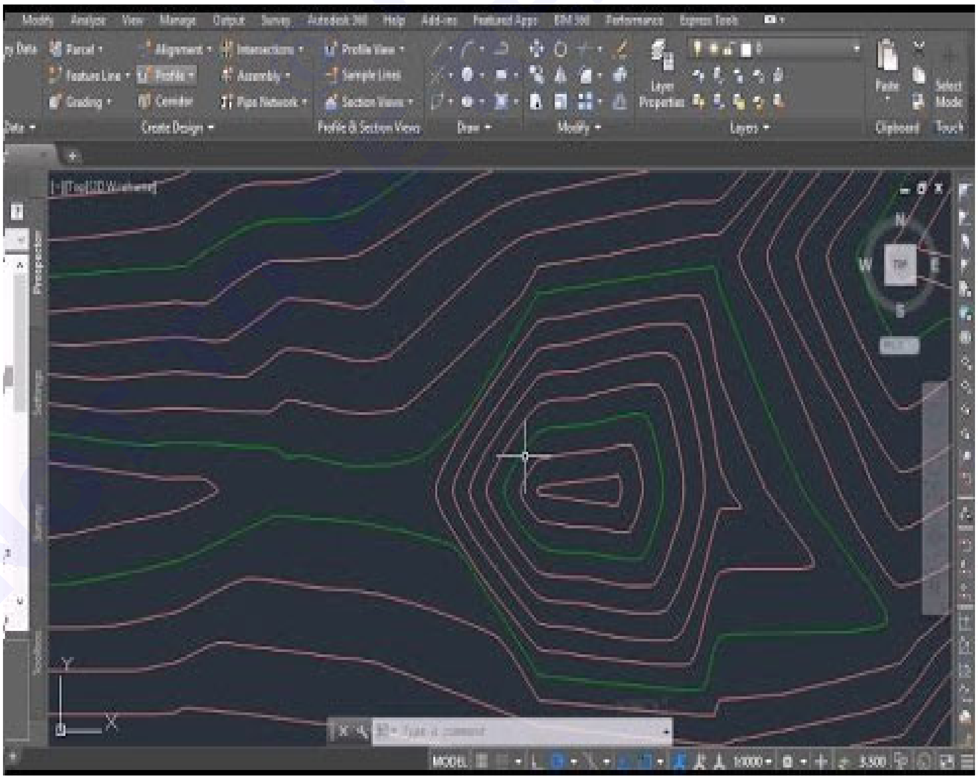

Modify Analyze View Manage Output Survey Autodesk 360 Help Add-ins Featured Apps BIM 360 Performance Express Tools
Parcel
Alignment
Intersections
Profile View
Feature Line
Profile
Assembly
Sample Lines
Grading
Corridor
Pipe Network
Section Views
Create Design
Profile & Section Views
Draw
Modify
Layer Properties
Layers
Paste
Clipboard
Select Mode
Touch
MODEL

Fig 5

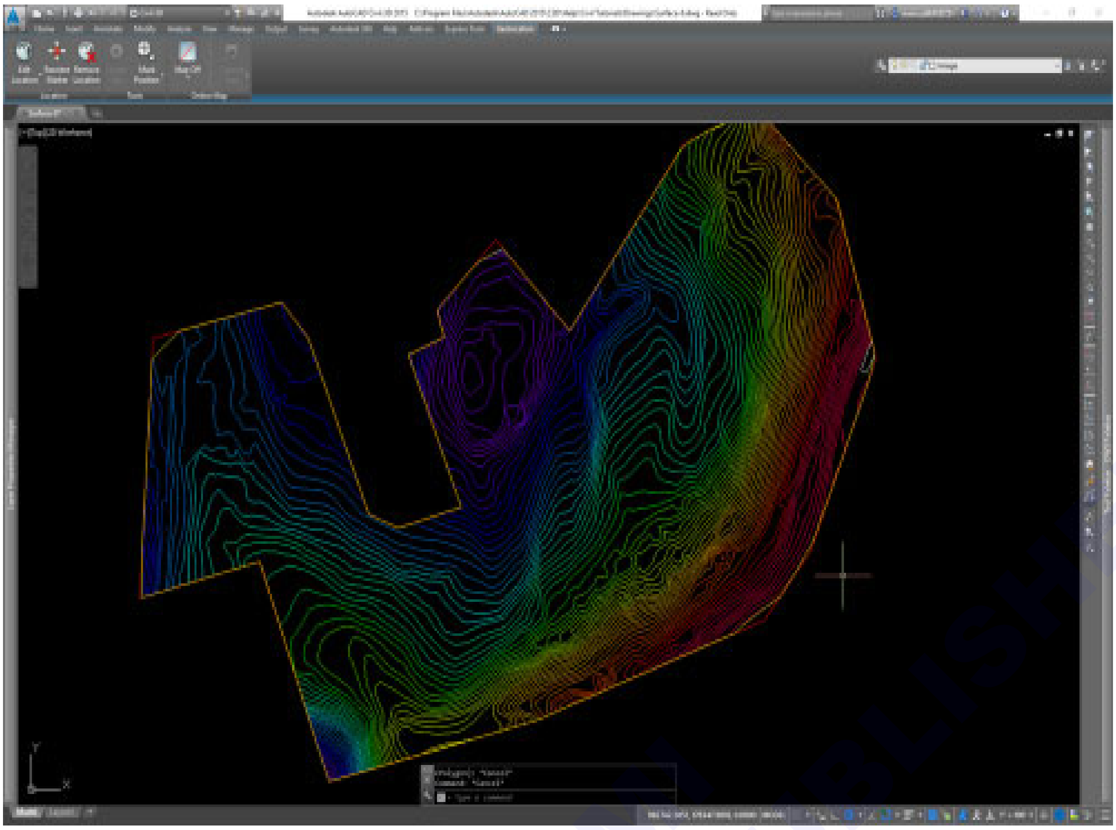


Fig 6

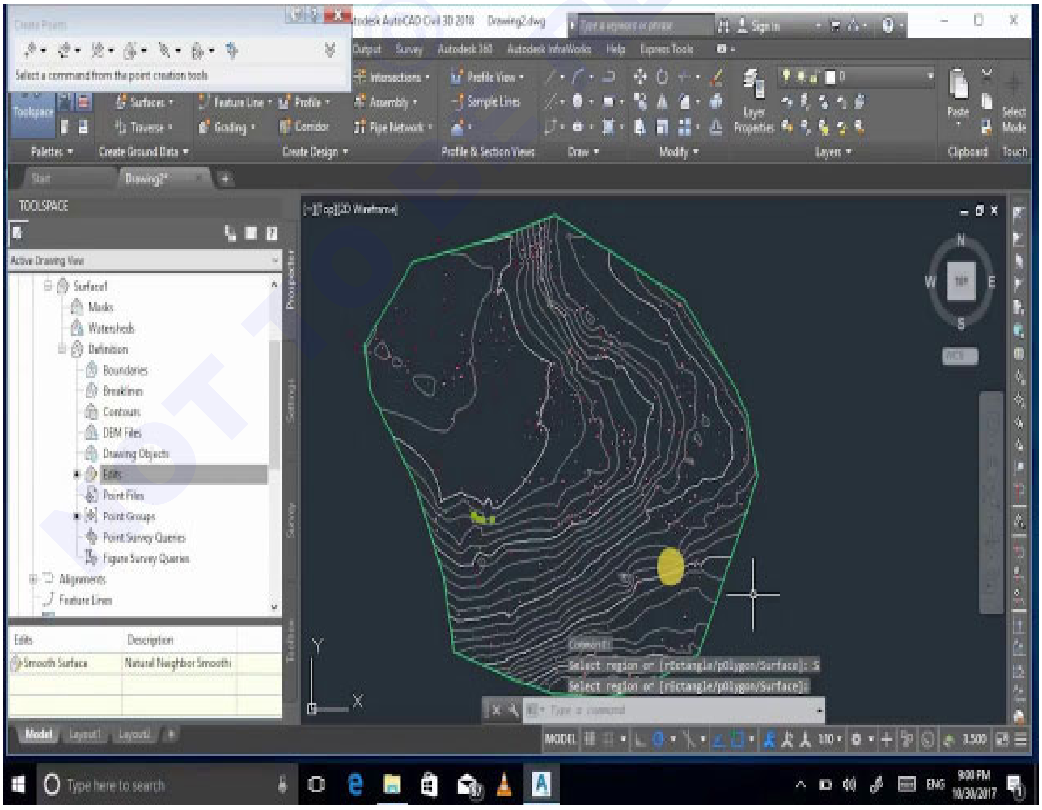


Fig 7

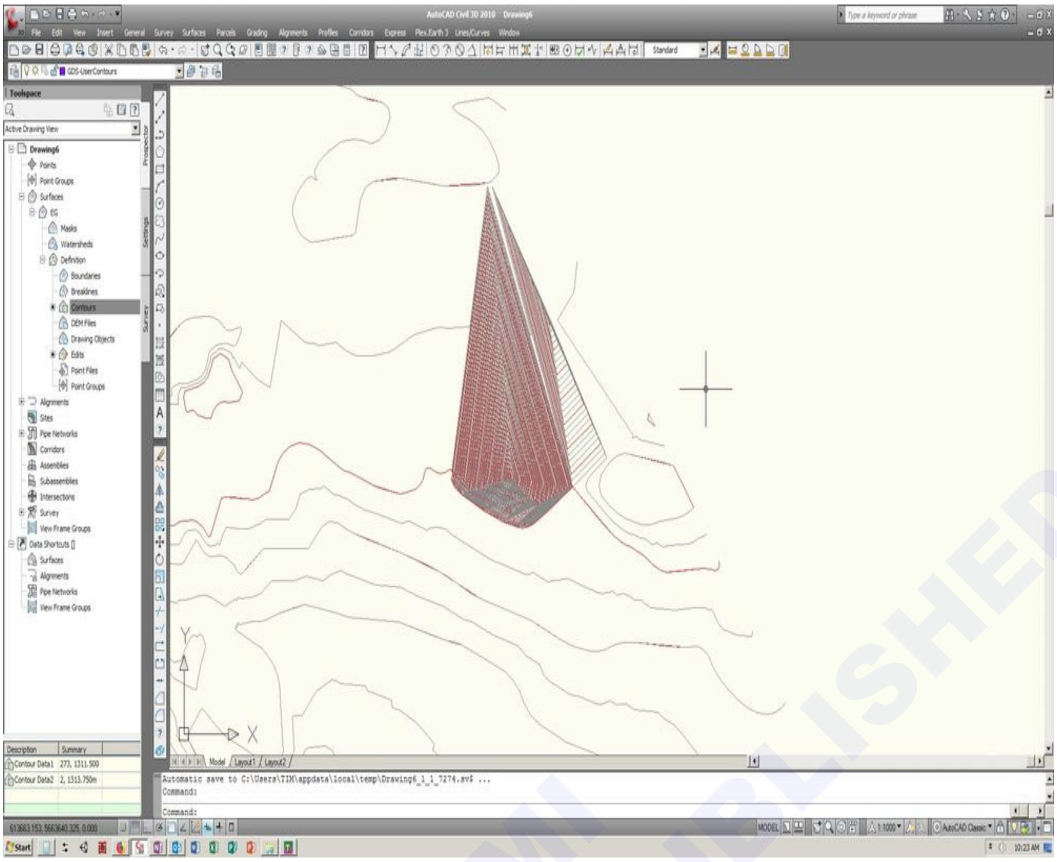
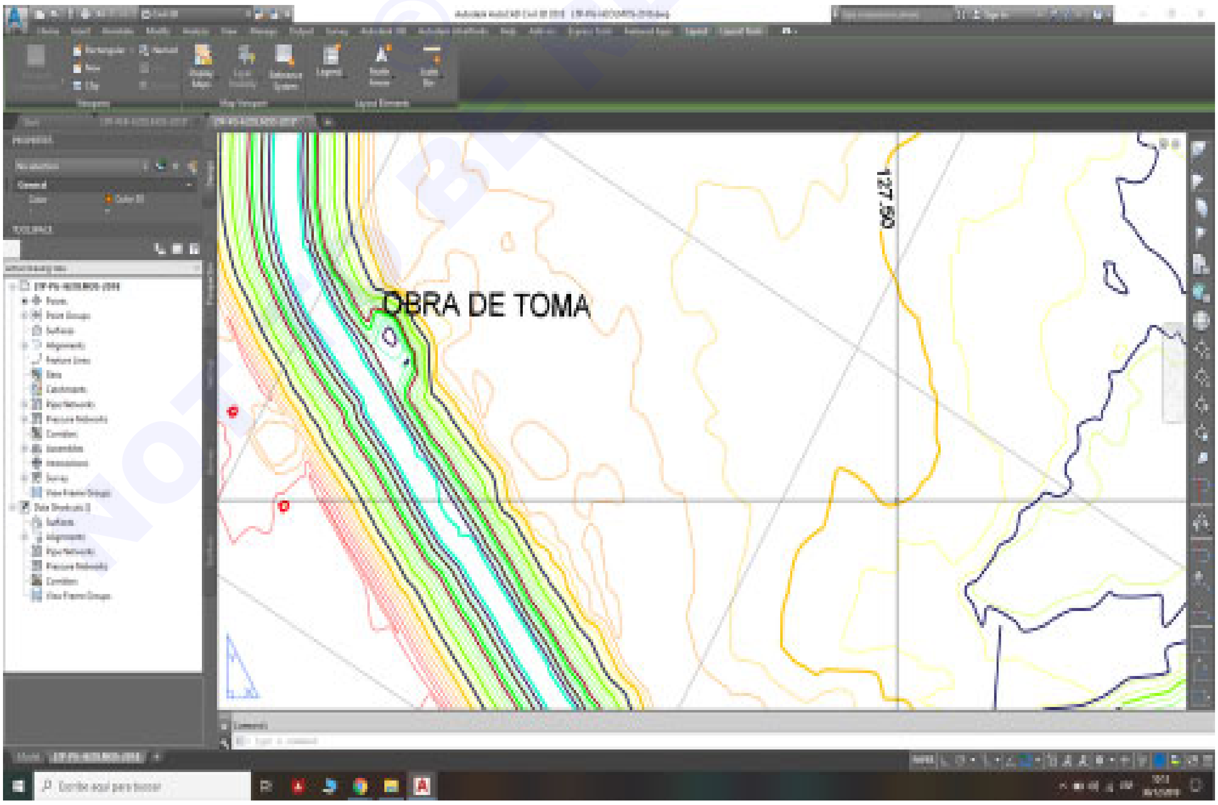


Fig 8



Determine hydrographic depth by (sounding method)/ECO sounder

Objectives: At the end of this exercise you shall be able to
- **prepare a navigation chart**
- **calculate the depth of the water level.**

Requirements

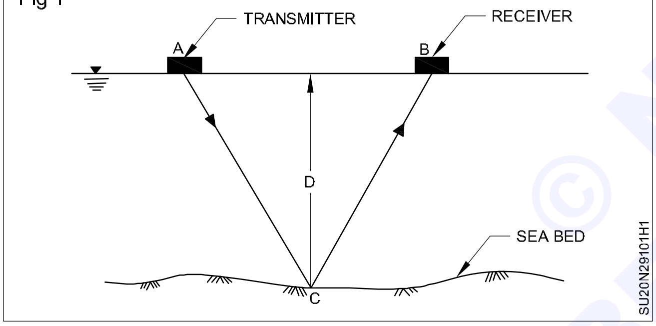
Tools/Instruments

- Shore signals and buoys
- Sounding equipments
- Instruments for measuring angles

Sounding in hydrographic survey (Fig 1)

The process of determining depth below water surface is called as sounding. The step before undergoing sounding is determining the mean sea level. If the reduced level of any point of a water body is determined by subtracting the sounding from mean sea level, hence it is analogous to levelling.

Fig 1



The specific need for sounding are:

1. Preparation of navigation charts that is an all-time information for future purpose also.
2. Material that to be dredged has to be determined early to facilitate easy movement in project without any confusion.
3. Material dredging should also accompany where filling has to be done. Material dumping is also measured.
4. Design of back waters, sea walls require detailed information that is obtained from sounding.

The explanations are given below

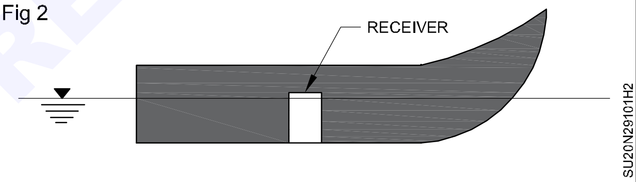
1 **Shore signal and buoys:** These are required to mark the range lines. A line perpendicular to shore line obtained by line joining 2 or 3 signals in a straight line constitute the range line along which sounding has to be performed. Angular observations can also be made from sounding boats by this method. To make it visible from considerable distance in the sea it is made highly conspicuous.

A float made of light wood or air tight vessel which is weighted at bottom kept vertical by anchoring with guy wires are called buoys. Under deep water the range lines are marked by shore signals & the buoys.

2 **Sounding equipment:** The individual units involved are explained one by one:

a **Sounding boat:** A flat bottom of low draft is used to carry out sounding operation. Large size boats with motor are used for sounding in sea. The soundings are taken through wells provided in the boat. A depicting sounding boat is shown in Fig 2.

Fig 2

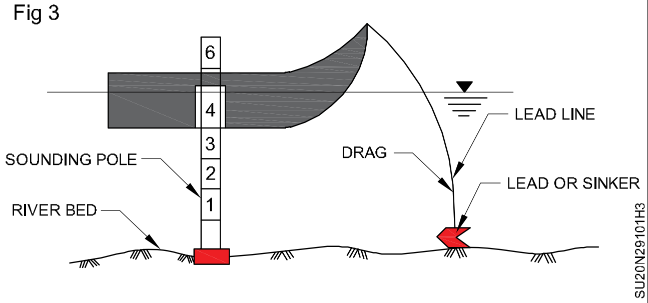


b **Sounding pole or rod:** Rod made of seasoned timber 5 to 10 cm diameter and 5 to 8m length. A lead shoe of sufficient weight is connected at bottom to keep it vertical. Graduations are marked from botom upwards. Hence readings on the rod corresponding to water surface is water depth.

c **Lead line:** A graduated rope made of chain connected to the lead or sinker of 5 to 10 kg, depending on current strength and water depth. Due to deep and swift flowing water variation will be there from true depth hence a correction is required. (Fig 3)

Other sounding equipment used are Weddell's sounding machine. These are employed when large sounding work has to be undergone. A standard machine to measure maximum of 30 to 40m is designed that are bolted over the well of the sounding boat.

Fig 3



Another equipment used is fathometer which is an echo-sounding instrument used to determine ocean depth directly. Recording time of travel by sound waves is the principle employed. Here the time of travel from a point on the surface of the water to the bottom of the ocean and back is recorded.

Knowing the velocity of sound waves the depth can be calculated as shown in figs 4 & 5.

From the figure the depth d can be calculated if AB can be found. This method gives more precise value methods. It is found more sensitive than a lead line.

$$timetakent = \frac{2Xd}{v}$$

$$\therefore d = \frac{vt}{2}$$

Hydrograhic survey

Determine hydrographic depth by sounding method/eco sounder**.**

Fig 4

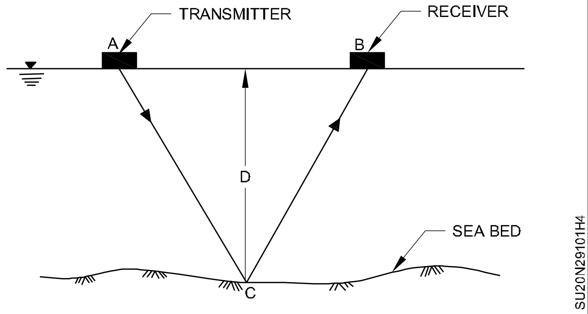
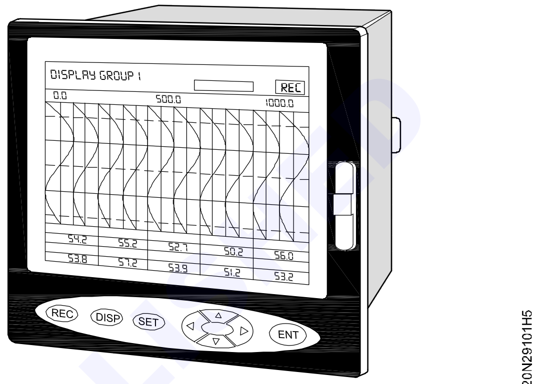


Fig 5



PAPER RECORDER

Measure the velocity of flow

Objectives: At the end of this exercise you shall be able to
- **describe flow measurement**
- **define level of flow and area/velocity**
- **describe dye testing and acoustic doppler velocimetry.**

PROCEDURE

TASK 1: **Describe Flow measurement**

- Flow measurement is the qualification of bulk fluid movement.
- Flow can be measured in a variety of ways.
- Positive displacement flow meters accumulate a fixed volume of fluid and then count the number of times the volume is filled to measure flow.
- Other flow measurement methods rely on forces produced by the flowing stream as it passes over known construction to calculate flow indirectly.
- Flow may be measured by measuring the velocity of fluid over a known area.
- For very large flows, tracer methods may be used.

Instruments for flow measurement

1 Mechanical flow meters

2 Pressure based meters

3 Variable over flow meters

4 Optical flow meters

Open channel flow measurement

- Flowing liquid has a top surface open to the air.
- The cross-section of the flow is only determined by the shape of the channel on the lower sides and is variable depending on the depth of liquid in the channel.
- Measuring flow in water ways is an important open-channel flow application: such installation are known as stream gauges.

Level of flow

- The level of the water measured using various secondary devices such as bubblers, ultrasonic, float.
- This depth is converted to a flow rate according to a theoretical formula.
- The flow rate can be integrated over time into volumetric flow.
- Level to flow devices are commonly used to measure the flow of surface waters. Such as stream and rivers.
- Weirs are used on flow streams with low solids.
- Flumes are used on flows containing low or high solid contents.

Area/Velocity

- The cross-sectional area of the flow is calculated from the depth measurement.
- The average velocity of the flow is measured directly (Doppler and propeller method)

There are two types of area velocity flow meter.

1 Wetted area

2 Non-contact area

Wetted area

- Wetted area velocity sensors have to be typically mounted on the bottom of a channel or river and use doppler to measure the velocity of the entrained particles.
- With depth and a programmed cross-section this can provide discharge flow measurement.

Non-contact area

- Non-contract device that use laser or radar are mounted above the channel and measure the velocity from the above and use ultrasound to measure the depth of the water from above.
- Radar devices can only measure surface velocities whereas laser based devices can measure velocities at sub-surface.

Dye testing

- A known amount of dye or salt per unit time is added to a flow stream.
- After complete mixing, the concentration is measured.
- The dilution rate equals the flow rates.

Acoustic doppler velocimetry

- Acoustic doppler velocimetry is designed to record instantaneous velocity compounds at a single point with a relatively high frequency.
- Measurement are performed by measuring the velocity of particles in a remote sampling volume based upon the doppler shift effect.

Name of the other meters

1 Thermal mass flow meters.

2 Vortex flow meters.

3 Sonar flow measurement.

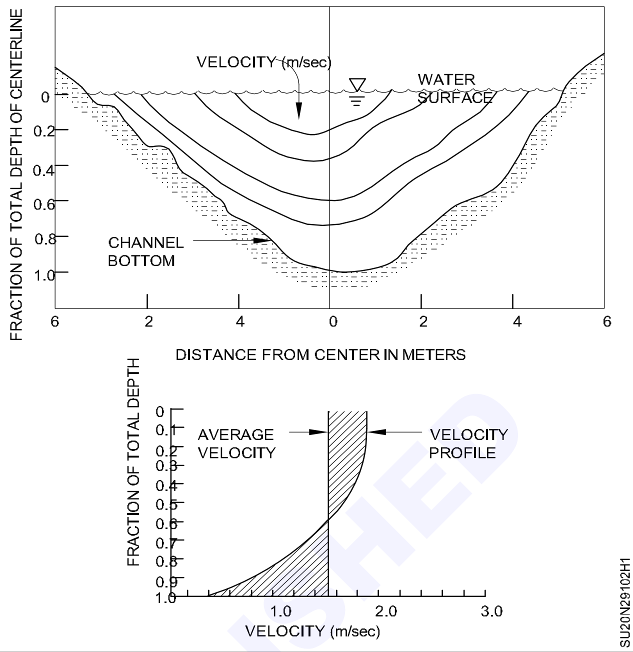
4 Electromagnetic, ultrasonic and coriolis flow meter.

5 Laser doppler flow measurement.

Measure the velocity of flow: Velocity can be measured directly, using a flowmeter (essentially a speedometer for water, Fig 1 or inferred by timing the movement of a float in the water. Velocity varies across a stream and with depth, depending primarily on the proximity of the stream. When using a flowmeter, a single measurement at approximately 60% of the depth will give stream will give a reliable vertical average.

Figure 1: Variation of stream velocity with depth

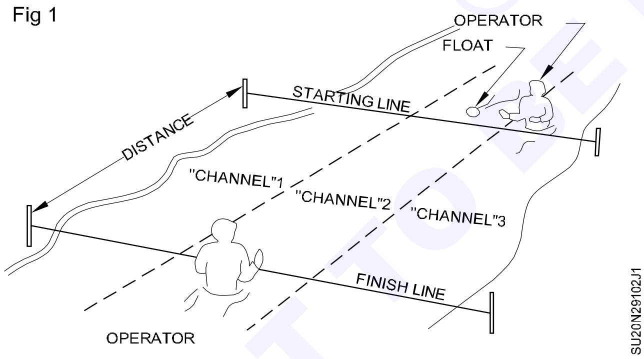
Fig 1



TASK 1: **Measurement of Flow velocity using float method**

1 Choose a suitable float: The float should have a specific gravity that is less than the fluid being measured so that it will float at the surface. The float should also be easily visible and have a streamlined shape to minimize drag. (Fig 1)

Fig 1



2 Determine the distance between two fixed points along the pipeline or channel where the float will be released and where it will be captured. (Fig 2)

3 Release the float into the fluid at the upstream point and start timing its travel.

4 Capture the float at the downstream point and stop the timer.

5 Calculate the velocity of the fluid using the following formula:

Velocity = Distance / Time

Where,

Distance: Distance between the two fixed points,

Time: Time taken for the float to travel between the two points.

6 Repeat the measurement several times and calculate the average velocity to obtain a more accurate result.

Fig 2

TASK 2: **Measurement of Flow velocity using current meter**

1 Choose an appropriate location to take the measurement. This should be a section of the stream or river where the flow is relatively uniform and free from obstructions.

2 Lower the current meter into the water using a line or cable. The meter should be suspended at a depth of 0.5D (where D= depth of water).

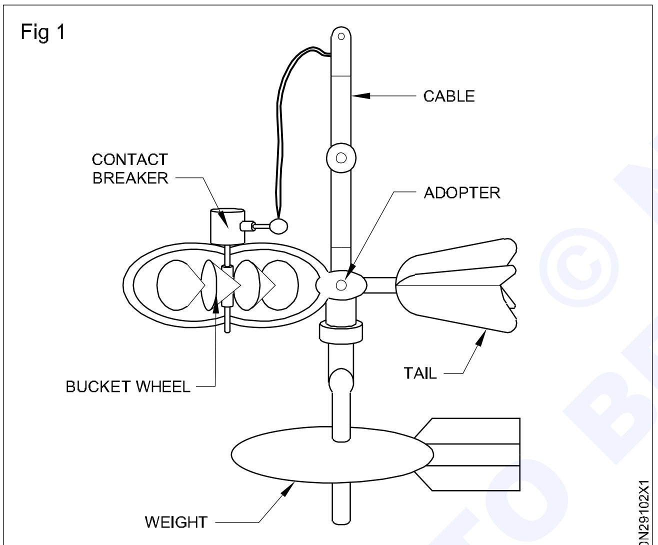
3 Allow the meter to stabilize for a few seconds to ensure that it is not moving and the rotor is not turning.

4 Start timing and note the number of revolutions made by the rotor in a given time from the data recorder. The time period you choose will depend on the flow rate, but 30 seconds is often used as a standard.

5 Velocity of flow can be found out from the calibration chart provided by the manufacturer.

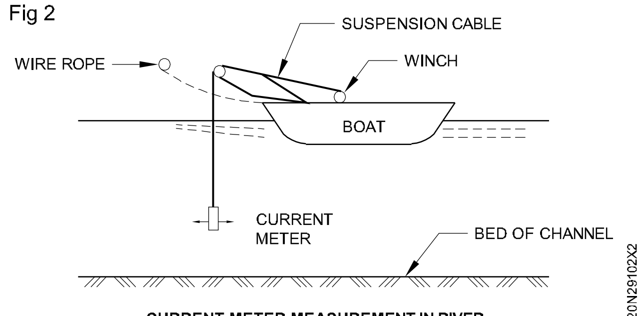
6 To get mean velocity of the section, the observed velocity should be multiplied with a coefficient 0.96. Generally mean velocity of flow at a section is obtained by keeping the meter at 0.6 B (where B = width of stream) (Figs 1 & 2)

Fig 1



CURRENT METER

Fig 2



CURRENT METER MEASUREMENT IN RIVER

Rating of current meter

1 Current-meter is rated in a long tank (say 150 m long) with sectional area 4 m x 2.5 m.

2 On both sides of the tank rails are provided.

3 A trolley runs over the rails with known velocities.

4 Generally, an equipment is provided on the trolley to automatically record the current-meter revolutions, time and distance travelled.

5 A current-meter is lowered in the still water of the tank from the trolley by a suspension rod.

6 The trolley is run over the tank at different known velocities for number of times.

7 The number of rotations of the current-meter cup wheel for various velocities is noted.

8 From the readings a rating curve is prepared. It comes out to be a straight line and the equation is of the form V = M R + C

where V is velocity, R is revolutions of cup wheel per second and M and C are constants.

9 Every current-meter whether new or old should be rated before putting it into use. In addition, it is essential to calibrate every current-meter periodically.

— — — — — — — —

Determine the cross sectional area of a river

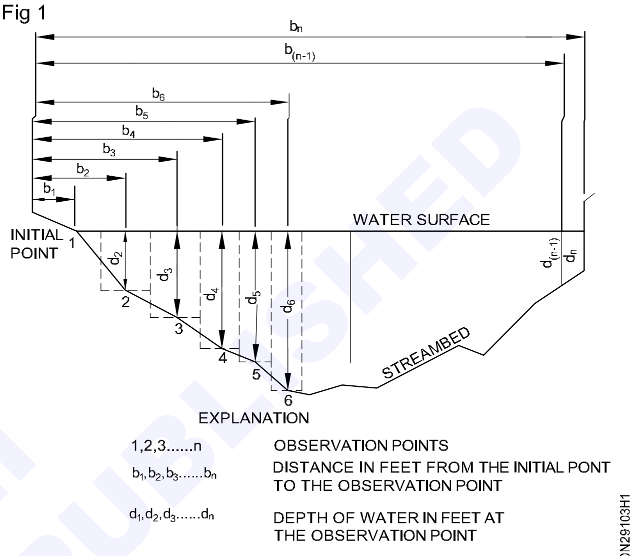
Objectives: At the end of this exercise you shall be able to
- **compute river cross sectional area.**

TASK 1: **Determine the cross sectional area of river**

The simplest approach to measuring cross-sectional area is to locate a number of points on the stream bottom by measuring down from the tagline (or yardstick) at regular intervals. Then draw these locations (and the water surface) to scale on graph paper, and count the squares to determine the area. Second method is to approximate the area by a series of rectangles, as shown in Fig 1.

If you measure depth at regular intervals (e.g. 2 cm), then the width of each rectangle is constant.

Fig 1



MEASUREMENT OF STREAM CROSS-SECTIONAL AREA

TASK 2: **Calculate the cross sectional area of a river using approximate method**

1 Select AB, CD and EF sections of the river and pull cables at all these sections across the river.

2. The distance between sections AB, CD, and CD, EF may be anything, say 100 m.

3 Wooden battens are attached to all the cables and sections of river at the cable points are divided into equal parts.

4 In this case, each cable divided into seven equal parts as shown in Fig 1.

5. Thus the river width gets divided into seven equal parts longitudinally.

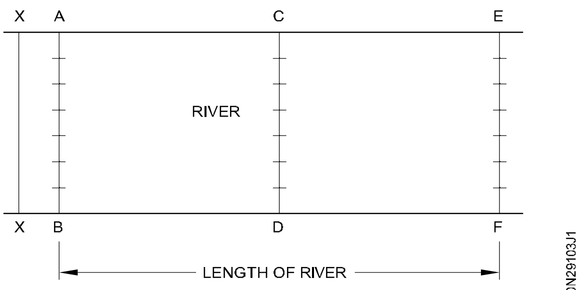
6 Now take a staff or any other graduated rod and measure the depth of the river at the centre points of the each of the seven parts.

7 Compute the areas of all seven compartments by multiplying the width of the water of each compartment by the depth of the water.

8 The sum of all these areas is the cross-sectional area (A) of the flowing water of the river.

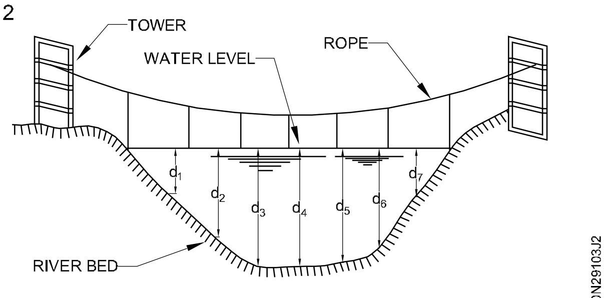
9 If it is not possible to measure the depth of water with staff or graduated rod, it can be measured by using Echo sounder.

Fig 1



RIVER LENGTH

Fig 2



CABLE DIVIDED INTO SEVEN EQUAL PARTS

Calculate the discharge of a river

Objective: At the end of this exercise you shall be able to
- **measuring and calculating stream flow discharge.**

Requirements

Tools/Instruments

- Drawing board with drafting machine - 1 No.
- 30 cm scale - 1 Set
- Sets square (45° & 60°) - 1 Set
- Instrument box - 1 No.

Materials

- A2 size drawing paper - 1 No.
- Eraser - 1 No.
- Pencils H & HB - 1 No. each
- Cellotape - as reqd.
- 2 flags to mark the start and end of the stream
- Monitoring section
- Measuring tape
- Orange or other float device
- Appropriate footwear (boots or water shoes)
- Personal flotation device (when requested by teacher)
- Stopwatch
- Calculator

Safety: Do not enter a stream that is moving fast or if the water level is above your thigh. If at any time you feel you may lose your balance, exit the stream. If requested by your teacher, wear a personal flotation device. Wear appropriate footwear in and out of the stream.

PROCEDURE

TASK 1: **Set-up**

1 Locate a straight section of stream atleast, 20 feet long. Mark the start and end of the length of stream with flags.

2 Measure the width of the stream and record data in table 1.

3 Measure the depth (in tenths of an inch) of the stream at 1 foot intervals. Record data in Table 2.

4 Observe the bottom of the stream. Define below the best description of the stream bottom.

a Rough, loose rocks, coarse gravel, weeds.

b Smooth mud, sand, bedrock.

Measuring velocity

5 Release your float 3-4 feet upstream of the "Start" flag.

6 Measure the time taken by the float to travel the distance between flags. With the students in small groups, have one student in the water ready to release the float object, one on shore watching the starting line, another watching the finish line, one using the stopwatch and all others in the water behind the finish line to catch the object. Time the distance between flags. Record in data Table 1.

7 Repeat step 4 and 5 at three additional locations across the stream, Record data in Table 1.

Table 1

	Width of stream	Float distance measure	Time to travel distance
Location 1			
Location 2			
Location 3			
Location 4			
		Average travel time	

Table 2

Depth 1	Depth 2	Depth 3	Depth 4	Depth 5	Depth 6	Depth 7	Depth 8	Depth 9	Depth 10	Average Depth

Multiply the average depth of the stream by the width of the stream to find the area in ft^2.

Divide the distance travelled by float with the average travel time to find the velocity of stream in ft/sec.

Multiply the velocity of the stream by a correction factor. This is corrected velocity of the stream.

a Choose a correction factor of 0.8 for stream bottoms with rocks, coarse gravel or weeds.

b Choose a correction factor of 0.9 for stream bottoms with smooth mud, sand or bedrock.

Multiply the corrected velocity of the stream by the area of the stream to obtain ft^3/sec. This is the measure of stream flow in cubic feet per second!

Based on your data analysis, write a conclusion for this activity.

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TASK 2: **Draw the discharge calculation diagram of various cross section (Figs 1 to 7)**

Note: Instructor should guide the trainees in developing the diagram

Fig 1

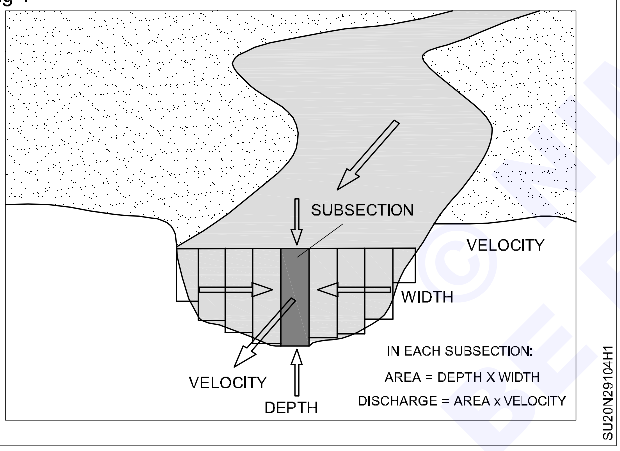


Fig 3

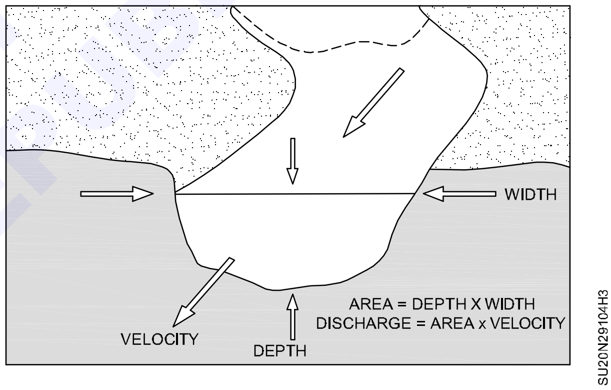


Fig 2

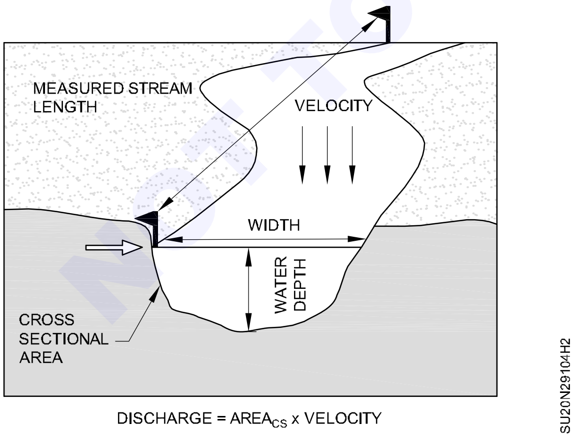


Fig 4

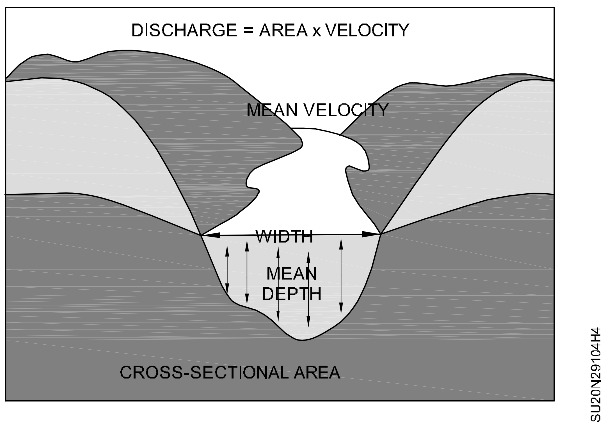
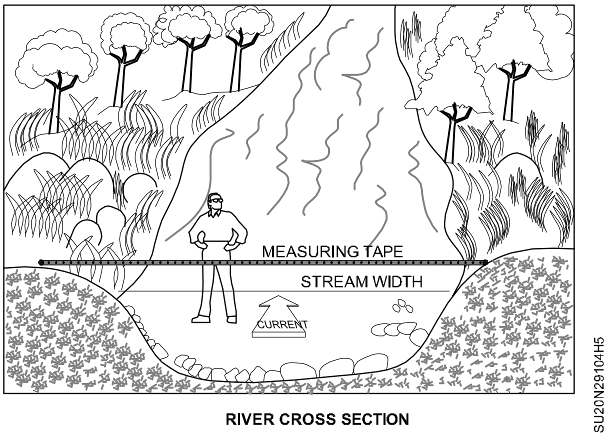


Fig 5



RIVER CROSS SECTION

Fig 6

CROSS SECTION OF STREAMFLOW MEASUREMENT
SHOWING POINTS OF OBSERVATIONS AND VELOCITY

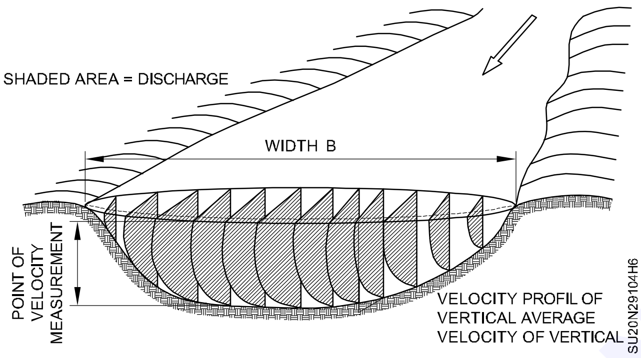
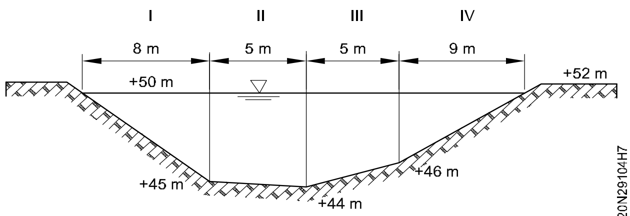


Fig 7

SUB-SECTION	I	II	III	IV
ROTATION N AT 0.6d	39	58	70	60
OBSERVATION TIME (SCC)	100	120	180	120



RIVER CROSS SECTION

Justify to constructing a new transmission line

Objectives: At the end of this exercise you shall be able to
- **requirement of transmission line routing.**
- **draw components of transmission line**
- **sketch line clearance requirements.**

Requirements

Tools/Instruments

• Drawing board with drafting machine	- 1 No.
• 30 cm scale	- 1 Set
• Sets square (45° & 60°)	- 1 Set
• Instrument box	- 1 No.

Materials

• A2 size drawing paper	- 2 Nos.
• Eraser	- 1 No.
• Pencils H & HB	- 1 No. each
• Cello tape	- as reqd.

PROCEDURE

TASK 1: **Requirement of transmission line routing**

1 The alignment of the transmission line shall be most economical from the point of view of construction and maintenance.

2 Routing of transmission line through protected/reserved forest area should be avoided.

3 The route should have minimum crossings of major river, railway lines, highway, overhead electric high voltage (EHV) power line and communication line.

4 The distance between the terminal points should be shortest.

5 Marshy and low lying areas, river beds and earth slip zones shall be avoided.

6 It would be preferable to utilize level ground for the alignment.

7 Alignment will be kept at a minimum distance of 300 m from power lines to avoid induction problem on lower voltage lines.

8 Crossing of communication line shall be preferably at right angle proximity and parallel with telecom lines shall be eliminated to avoid danger of induction to them.

9 Area subjected to flood should be avoided.

10 Restricted areas such as civil and military air field shall be avoided and also avoid aircraft landing approaches.

11 All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.

12 Certain areas such as quarry sites, agriculture fields which will present the owner problems in acquisition of right of way should be avoided.

13 Angle points should be selected such that shifting the point within 100 m radius is possible at the time of construction of the line.

14 The line routing should avoided large habitations densely populated areas to the extent possible.

15 For examination of the alternatives and identification of the most appropriate route, make use of informations data/details extracted through survey of India.

16 Use topographical maps and computer aided processing of NRSC satellite imagery and also carryout reconnaissance/preliminary survey as may be required for verification and calculation of additional data.

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TASK 2: **Components of transmission line**

Selection of tower structure:

Understand the following details

1 Single circuit tower/double circuit tower

2 Length of the insulator assembly

3 Minimum clearances to be maintained between ground conductors

4 Location of ground wire/wires with respect to the outermost conductor

5 Midspan clearance required from consideration of the dynamic behavior conductors and lightning protection of the line

- Minimum clearance of the lowest conductor above ground level

Typical 765 KV Tower structure (Fig 1)

Height of tower structure

H = h1+h2+h3+h4

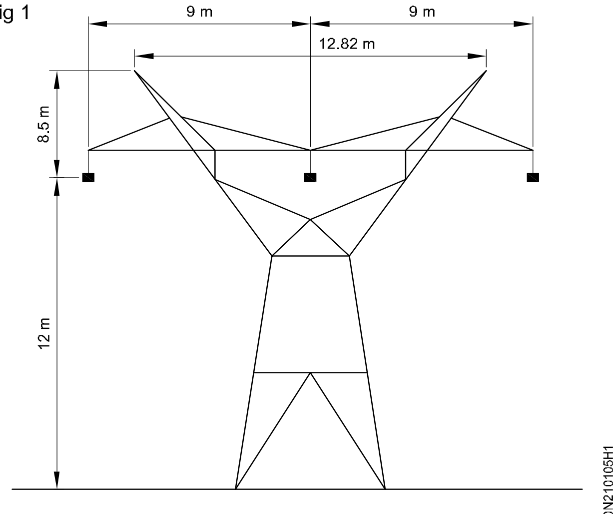
h1 = minimum permissible ground clearance

h2 = maximum sag

h3 = vertical spacing between conductors

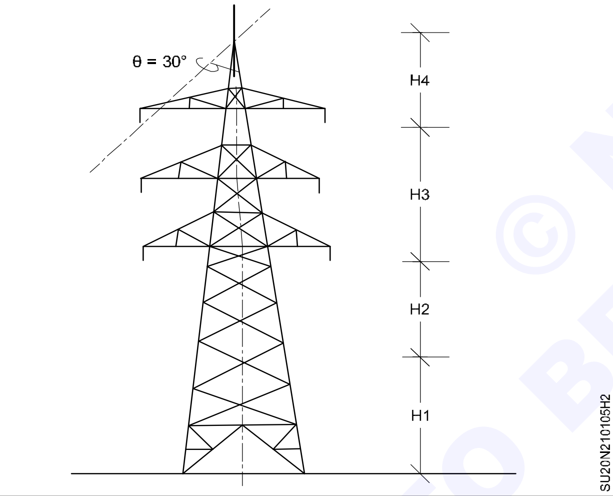
h4 = vertical clearance between earth wire and top conductor (Fig 2)

Fig 1



TYPICAL 765 KV TOWER STRUCTURE

Fig 2



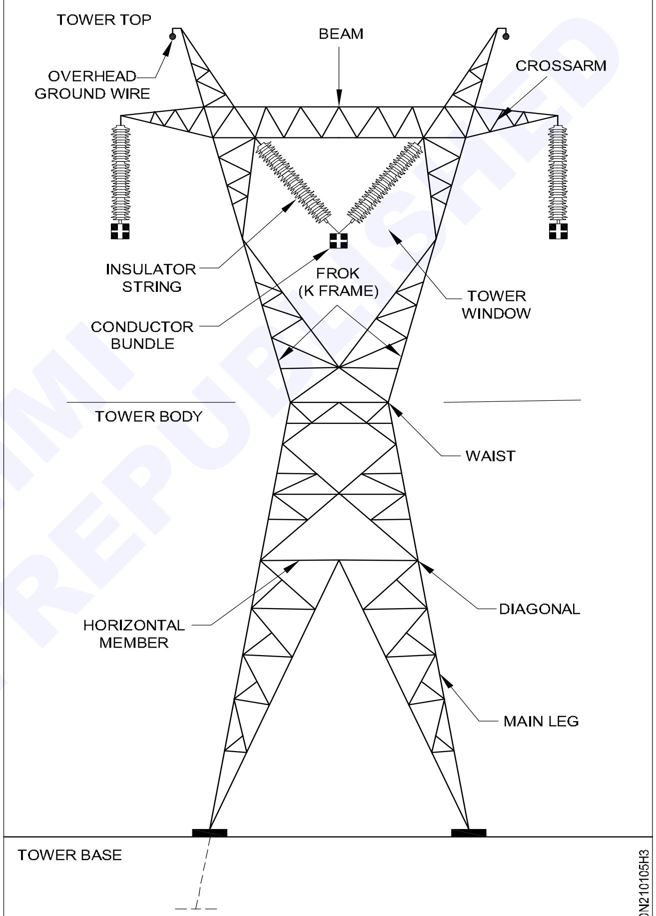
Minimum permissible ground clearance as per Indian Electricity (IE) rules 1956 shown in Table 1.

Components of transmission line tower. (Fig 3)

Table 1

S.No.	Voltage level	Ground clearance(m)
1.	≤33 KV	5.20
2.	66 KV	5.49
3.	132KV	6.10
4.	220 KV	7.01
5.	400 KV	8.84

Fig 3



COMPONENTS OF TRANSMISSION LINE TOWER

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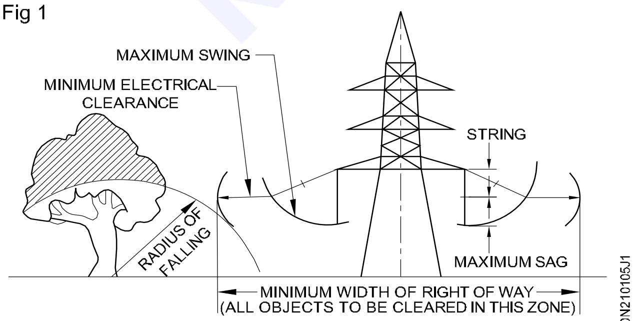
TASK 3: **Line clearance right of way requirement. (Fig 1)**

Fig 1



LINE CLEARANCE (RIGHT OF WAY) REQUIREMENT

Marking of tentative alignment on existing topographical map

Objective: At the end of this exercise you shall be able to
- **understand topographical survey.**

PROCEDURE

Study the drawings of topographical survey. (Figs 1 to 8)

Once, justification is done to construct a new transmission line then the next step is marking of different alignments which are likely to support the new transmission line. You should consider the requirements of alignment from preliminary survey when marking is done carefully. To make a decision for marking of alignment various alterations are required, so collect as much as copies of topographical maps available for the selected regions.

Fig 1

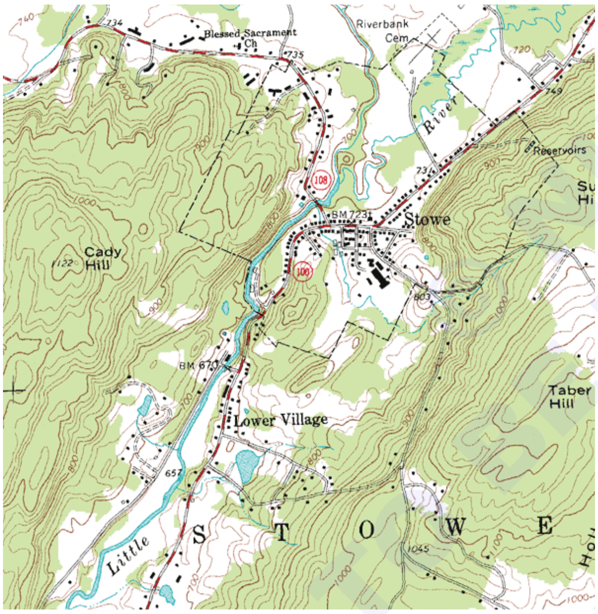


Fig 2

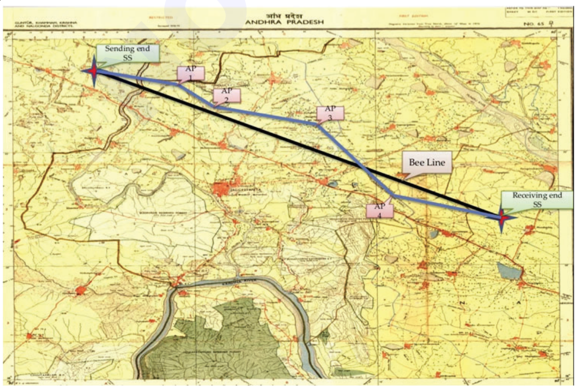


Fig 3

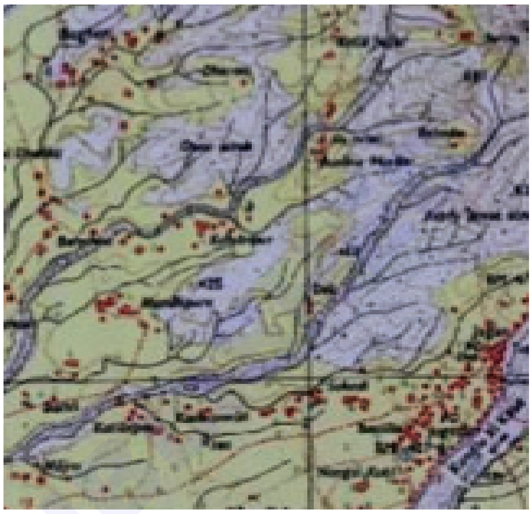


Fig 4

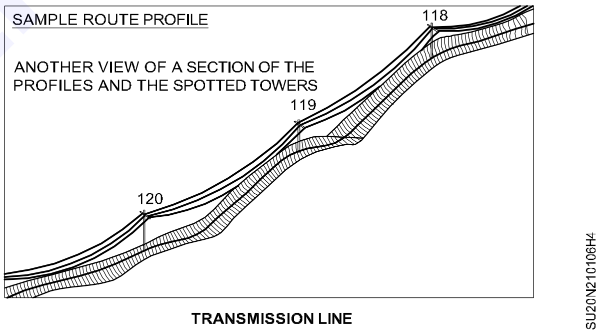


Fig 5

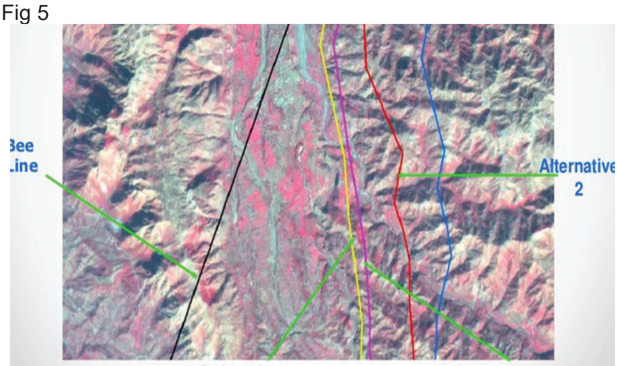


Fig 6

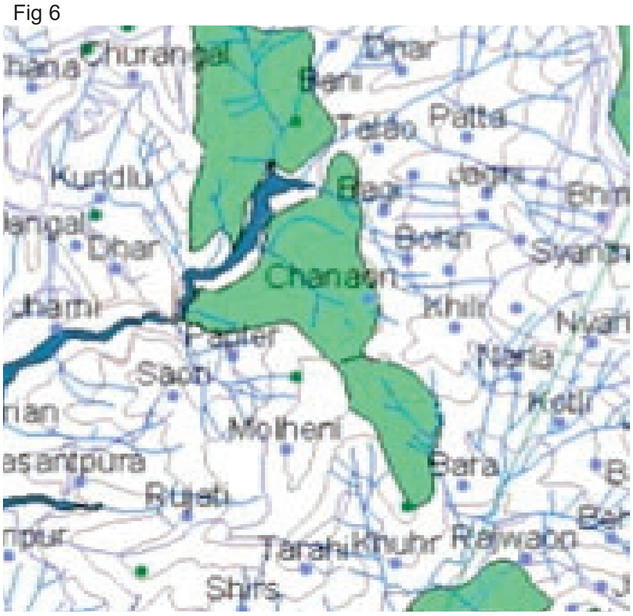


Fig 7

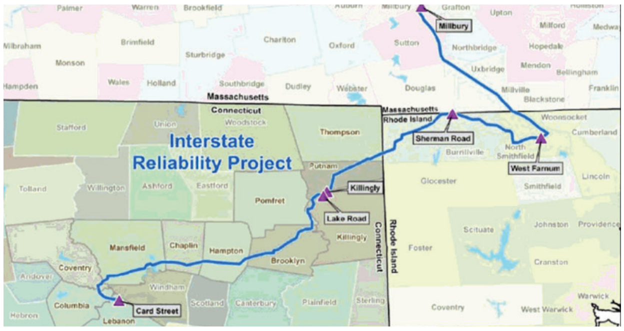
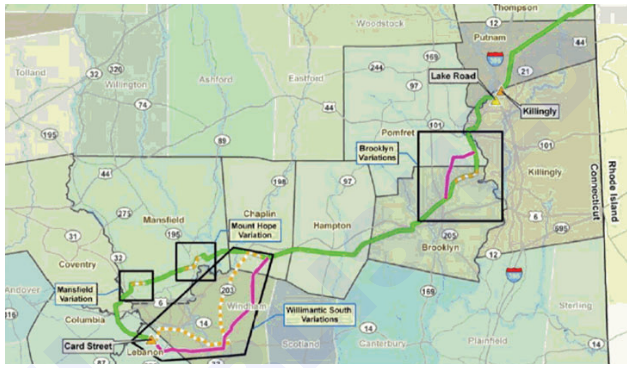


Fig 8



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Conduct reconnaissance/preliminary survey & select a good alignment

Objective: At the end of this exercise you shall be able to
- **perform reconnaissance survey and mark good alignment.**

Requirements

Tools/Instruments

- Prismatic compass with tripod - 1 No.
- Measuring tape 30 m - 1 No.
- Ranging rod 2/3 m long - 2 Nos.
- Arrows 40 cm long - 10 Nos.

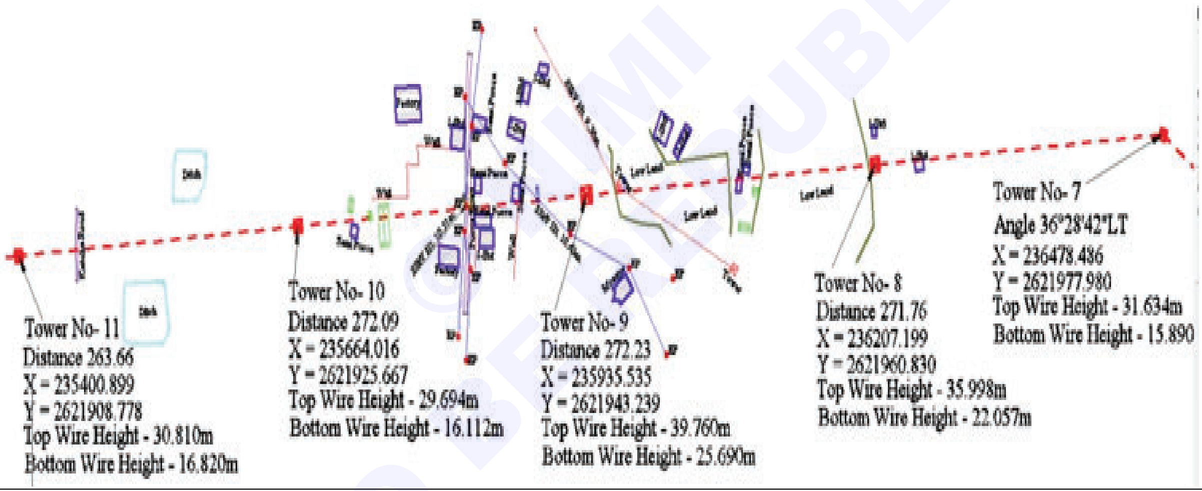
Materials

- Field note book
- Pencil
- Eraser

PROCEDURE

TASK 1: **Perfom reconnaissance survey (Fig 1)**

Fig 1



1 Use prismatic compass, find out the magnetic bearing of lines of alignment.

2 Find the distances by stepping.

3 Both measurements should be recorded in the field book.

- Study the surrounding area of alignment about 100 meters radius and locate the position of different objects.

4 Determine presence of water table level along the alignment using boring.

5 Soil survey should be done along the alignment.

6 Note down the number of bridges, culverts, rivers etc., along the alignmnent.

7 Note down the crossing points like roads, rivers etc., along the diagram.

8 Note down the number of curves present along the alignment.

9 Determine the slope of the ground along alignment using abney level.

10 Avoid the depressions and high summits.

11 Note down past recorded values of rainfall discharge by the rivers.

Reconnaissance survey preparation:

- The G. T. sheets provided by the Survey of India are best available maps. The maps covering the complete proposed route of the line shall be obtained.
- Obtain the maps which cover the topography of the land at an additional distance of 10 km on both sides of the proposed line.

- The scale of these maps shall be 1:50,000, i.e., 1 cm. = 500 metres. These maps are also required for the purpose of obtaining various clearances for the line route.
- These maps give details of the location of villages, towns, cities, ponds, lakes, rivers, roads, plantations, religious places, hilly area, sand dunes, etc.,
- A walkover reconnaissance and route alignment survey is first carried out. A vehicle may also be used wherever the terrain permits and where long distances can be seen without obstacles.

Various important field data required for transmission line works are as below. (Fig 2)

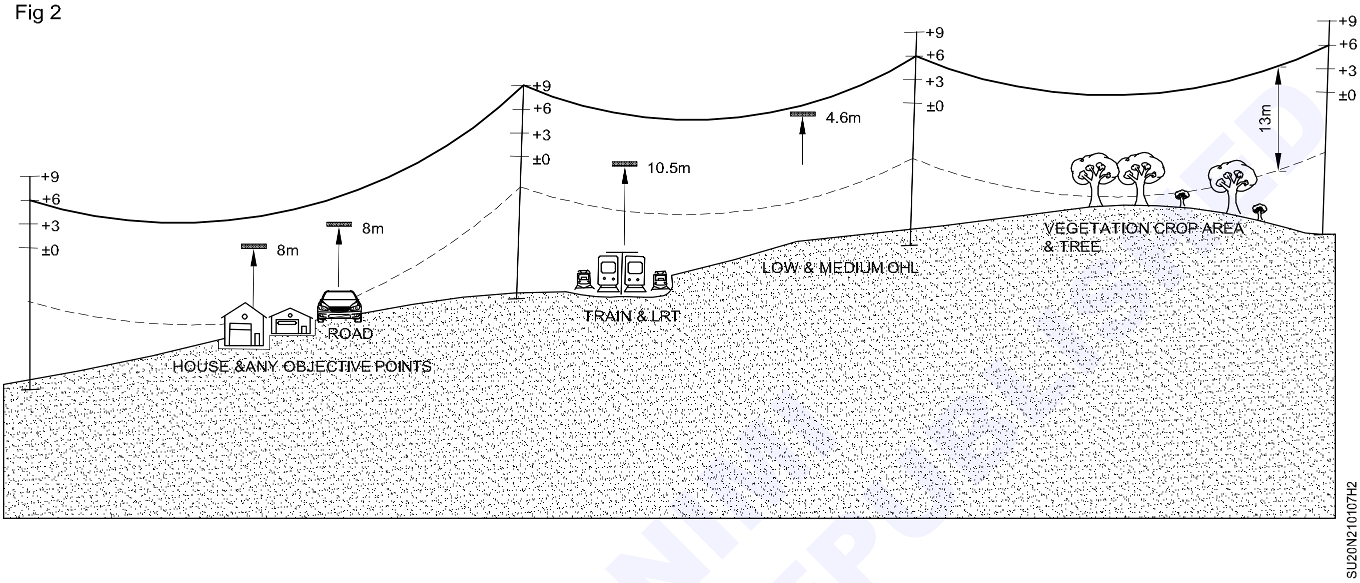
a Crossing points of major Extra High Voltage (EHV) lines (66 KV and above) Railway Tracks, major rivers.

b Type of terrain and nature of soil strata along the line route.

c Names of major towns.

d Important villages or towns coming enroute.

Fig 2



TASK 2: **Perform preliminary survey of alignment (Fig 1)**

1 Command a pillar at the starting point of alignment and this point is connected to nearby GTS bench mark using fly levelling.

2 The interval of longitudinal levelling is 20 or 40 meters and carried out along the alignment.

3 Carry out the cross levelling with an interval of 100 meters.

4 Noted in level book, the magnetic bearing of each line of traverse.

5 Prepare a survey route map, which give the details 100 m land on both sides of alignment. This can be done plane table surveying or prismatic compass surveying.

6 At every 2 km or with regular interval permanent bench mark are established.

7 Prepare a map for the marked station yards using plane table surveying.

8 At river crossings, the details of river like its cross section, width, water level, high flood level, secure depth etc., are noted for a distance at 1000 m, on both sides, crossing with an interval of 100 m.

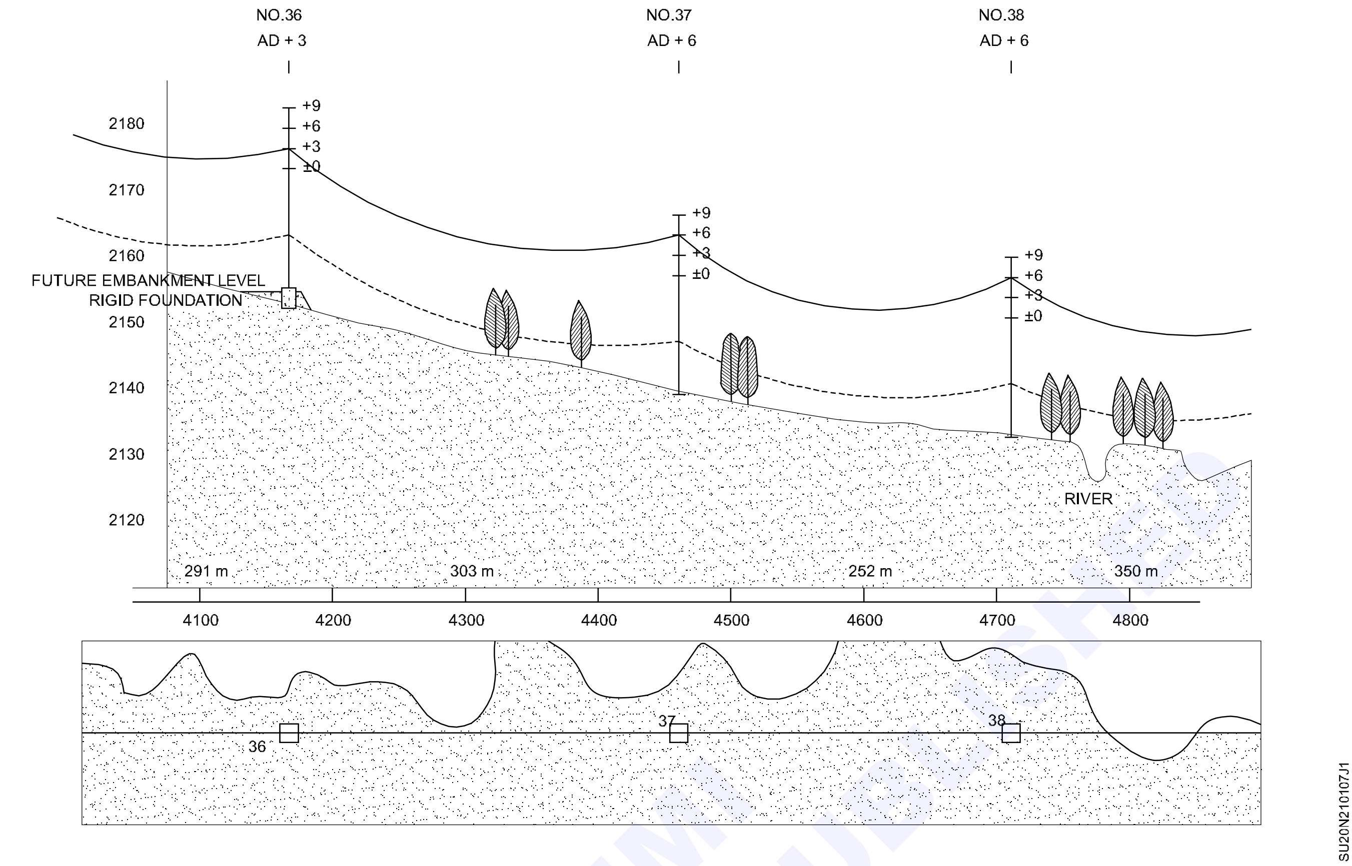
9 With all the recorded readings, a drawing is prepared for the whole alignment.

10 Prepare an approximate estimate for each alignment.

Perform preliminary survey of alignment and preparation

- The tentative line route is continuously examined and evaluated with reference to the criteria described in the previous exercise.
- Changes are proposed / made in the line route wherever required.
- The best route, modified or alternate, is then provisionally marked on the maps. This route shall form the basis for the detailed survey of the line.
- A copy of the map of the line route is prepared in which the points where earth resistivity has been measured are indicated along with the values of the earth resistivity at such points.
- The alignments of the railway lines and telephone / telegraph lines near the route of the line are also marked on the map.

Fig 1



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TASK 3 : **Selection of good alignment**

The route of a transmission line is decided from the following main considerations.

- Shortest length, hence least capital cost.
- Ease during construction and ease in maintenance of the line (route near roads for easy approach & accessibility). Requirement of future loads (sub stations) near the proposed route so that the line can be easily connected.
- Required separation distance from parallel communication lines (P&T, Railways, etc.) for meeting the conditions of induced voltage for obtaining approval.
- Avoiding of forest areas as well as wild life sanctuaries.
- Maintaining statutory distances from Airports / Helipads.
- It is desirable to take the line as near the paths and roads as practicable without unduly increasing the length of the line so as to facilitate transportation of material during construction and the patrolling / maintenance of the line.

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Conduct detailed survey, prepare a profile drawing using sag template

Objectives: At the end of this exercise you shall be able to
- **prepare sag template**
- **prepare a profile drawing.**

Requirements

Tools/Instruments

- Dumpy level - 1 No.
- Metric drain 30m - 1 No.
- 30 cm scale - 1 No.
- Sets square (45° & 60°) - 1 Set
- Instrument box - 1 No.

Materials

- A2 size drawing paper - 1 No.
- Eraser - 1 No.
- Drawing pencils H & HB - 1 No. each
- Cello tape - as reqd.

PROCEDURE

TASK 1: **Detailed survey**

- The line route worked out during the preliminary survey, with changes if any, is used as the reference. The measurements of the angle points are again done.
- These angles are indicated as Right (R) or Left (L) as per the direction of deviation with reference to the starting point.
- The levels of the ground profile along the route of the line are taken. The reduced level (R.L.) of the ground at the starting point of the line is taken as 100.00 metres.
- The levels are generally taken at intervals of 30 metres along plain and evenly sloping ground. The levels are taken at shorter intervals wherever there are sudden changes in the ground profile.
- All the levels are calculated with reference to the assumed R.L. The levels of high hillsides or sand dunes on the sides of the line route are also taken so that horizontal and vertical clearance of the conductors from these can be checked.
- The method of taking level readings for preparation of longitudinal and cross section profile can be chain and dumpy level.
- The tachometric method is employed in hilly regions and such other inaccessible places where chaining is not possible. This method needs skilled surveyors having good understanding of the use of theodolite.
- In this method, both traversing and levelling is done by means of a tachometric theodolite (theodolite having stadia cross hairs fitted in the eye piece). The horizontal and vertical distances are computed with the help of readings (of the stadia wires) taken on the levelling staff held at the reading station
- All roads, trees, structures, buildings, huts, sheds, canals, wells, rivers, forest area, railway lines, P&T lines, power lines, ponds, hillsides, high sand dunes and other objects, etc. within 50 metres on both sides of line route should be noted.
- Wherever there are changes in the route surveyed earlier, the concrete pillars placed during the preliminary survey shall be relocated. Similarly, the wooden pegs placed in the preliminary should be removed from their earlier positions wherever there are changes.
- All readings of levels and observations are noted in the field book(s).

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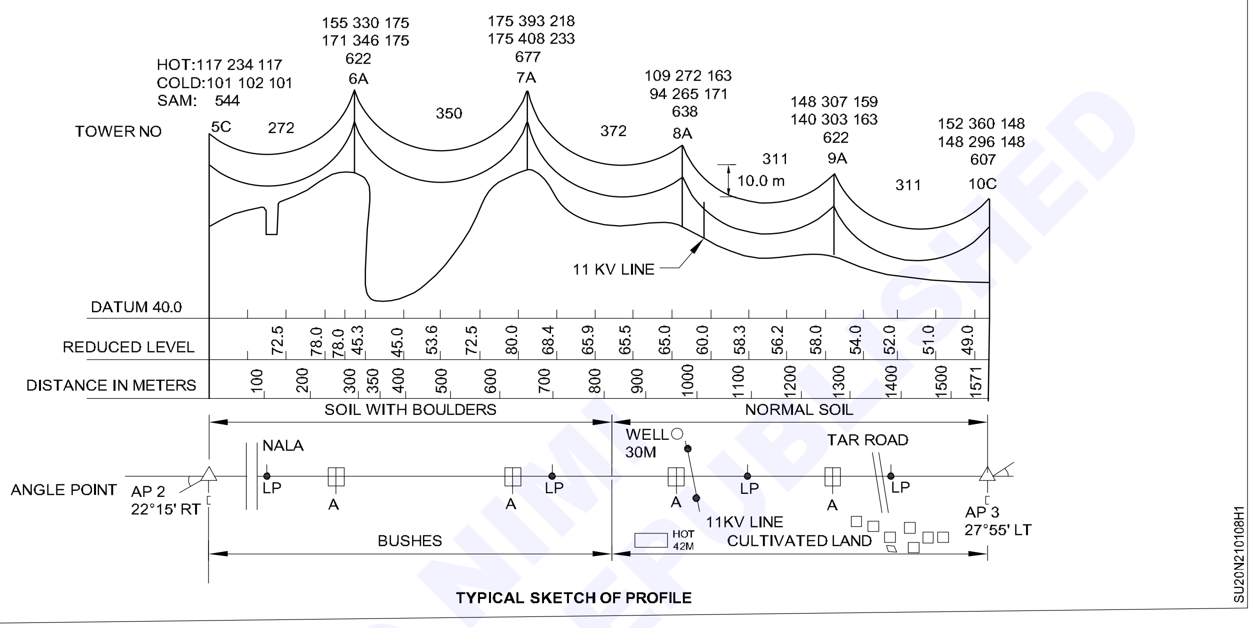
TASK 2: **Plotting of profiles (Fig 1)**

- From the field book entries, route plan and longitudinal profile, commonly referred to as 'Route Profile' or simply 'Profile', is prepared.
- The profile is prepared and plotted on 1mm / 5mm / 1cm square paper rolls of graphed tracing paper. The profile is plotted to a scale of 1 cm = 20 M horizontal and 1 cm = 2 M vertical.
- The profile shall progress from left to right.
- For hilly terrain, greater height of the sheet may be taken, or the sections may be plotted on separate sheets.

- The profile shall show the longitudinal profiles along the centre line of the transmission line route and also the cross section profile wherever appreciable difference in level exists with reference to the centre line level.
- The profile shall show the route plan giving details of all objects, nearby villages, important roads or rivers lying within 50 metres on both sides of the centre line of the route.
- Crossing details of any other power or telecommunication lines, roads, railway lines, canals or rivers shall be marked as clearly as possible.
- Readings shall be taken of the levels of roads, canal and river embankments, maximum water / flood levels, railway top levels and heights of supports / lines being crossed, and shall be shown in the offsets part of the profile. All trees coming within the zone of the right of way and which need to be cut / trimmed shall also be indicated.

Fig 1



Sag template

- A Sag Template is a very important tool with the help of which the position of towers on the profile is decided so that they conform to the limitations of vertical and wind loads on any particular tower, and minimum clearances, as per I.E. Rules, required to be maintained between the line conductor to ground, telephone lines, buildings, streets, navigable canals, power lines, or any other object coming under or near the line.
- A Sag Template consists of a set of parabolic curves drawn on a transparent celluloid or acrylic clear sheet duly cut in over the maximum conductor sag curve to allow the conductor curve to be drawn and the lowest points of the conductor sag to be marked on the profile when the profile is placed underneath it.(A typical calculation sheet for a sag template is enclosed at typical sketch profile image.)
- The set of curves in the sag template consists of: 'Cold or Uplift Curve' showing sag of conductor at minimum temperature (minus 2.5ºC) and still wind.
- 'Hot or Maximum Sag Curve' showing maximum sag of conductor at maximum temperature and still wind including sag tolerances allowed (normally 4%),
- 'Ground Clearance Curve' which is drawn parallel to the 'Hot or Maximum Sag Curve' and at a distance equal to the specified minimum ground clearance for the relevant voltage.
- 'Tower Footing Curve' which is drawn parallel to the 'Ground Clearance Curve' and separated by a minimum distance equal to the maximum sag at the basic design span.
- The Sag Template is plotted to the same scale as the profile, i.e., 1 cm = 20 M horizontal and 1 cm = 2 M vertical. It is generally plotted for spans up to 1000 metres.
- This is necessary for tower spotting when there are large variations in the ground levels along the line

TYPICAL SAG TEMPLATE CALCULATIONS

Example:

Conductor: ACSR "Zebra" (420 mm^2)

Construction: 54 Aluminium / 7 Steel / 3.18 mm

PARAMETERS:

Basic Span (ℓ) : 350 metres

Ultimate Tensile Strength of Conductor (U.T.S.) : 13290 Kg

Overall diameter of the Conductor (d) : 28.62 mm

Weight of the Conductor (W) : 1.621 kg / m

Wind Pressure (P) : 83.38 Kg /m^2

Coefficient of linear Expansion (α) : 19.3 × 10^{-6} per °C

Young's Modulus of elasticity (Final) (Ef) : 0.686 × 10^6 Kg/cm^2

Young's Modulus of elasticity (Initial) (Ei) : 0.4675 × 10^6 Kg/cm^2

Maximum temperature (Ambient) : 50°C

Maximum temperature (Conductor) : 75°C

Minimum Temperature (Ambient) : (-) 2.5°C

Minimum Temperature (Conductor) : (-) 2.5°C

Every day Temperature : 32.2°C

Area of Cross section of Conductor (A) : 4.845 cm^2

Factor of Safety (F.O.S.) (at 32.2°C) : 4

Factor of Safety (F.O.S.) (Otherwise) : 2

Weight of Conductor per unit area = W/A = 1.621/4.845 = 0.334571723 Kg /m / cm^2

Minimum Ground Clearance : 7.01 metres

CALCULATION:

Condition 1:

Temperature = 32.2°C

Wind = NIL

Factor of Safety = 4

Working tension; T1 = (U.T.S)/(F.O.S) = 13290/4

T1 = 3322.5 Kg

Working Stress; f1 = T1/A = 3322.5/4.845

f1 = 685.75851 Kg / cm2

Loading factor; q1 = $\left(\sqrt{P^2+W^2}\right)/W = 1$ (for no wind; P = 0)

The working stress is determined by the following formula:

$f1^2$ (f1 - k) = (l^2 δ^2 q_1^2Ef)/24

or, k = (-) 147.70198

condition 2

Temperature = 75 °C

Wind = NIL

Difference of temperature; t = 75 - 32.2 = 42.8 °C

To find the Working stress

$f2^2$ [f2 - (k - α t Ef)] = (l^2 δ^2 $q_2^2 E_f$)/24 or f2 = 555.553321 Kg / cm^2

Working tension; T2 = f2 × A = 555.553321 × 4.845

= 2691.656 Kg / cm2

Maximum Sag; s = ℓ^2 x δ x q_2 / (8 × f_2)

= 9.22 metres

Condition 3

Temperature = (-) 2.5 °C

Wind = NIL

Difference of temperature; t = - 2.5 - 32.2 = - 34.7 °C

Working stress f_3 = 851.8511701 Kg / cm_2

Working tension; T_3 = f_3 × A

= 851.8511701 × 4.845

= 4127.219 Kg / cm^2

Maximum Sag; s = ℓ^2 x δ x q_3 / (8 × f_3)

= 6.01 metres

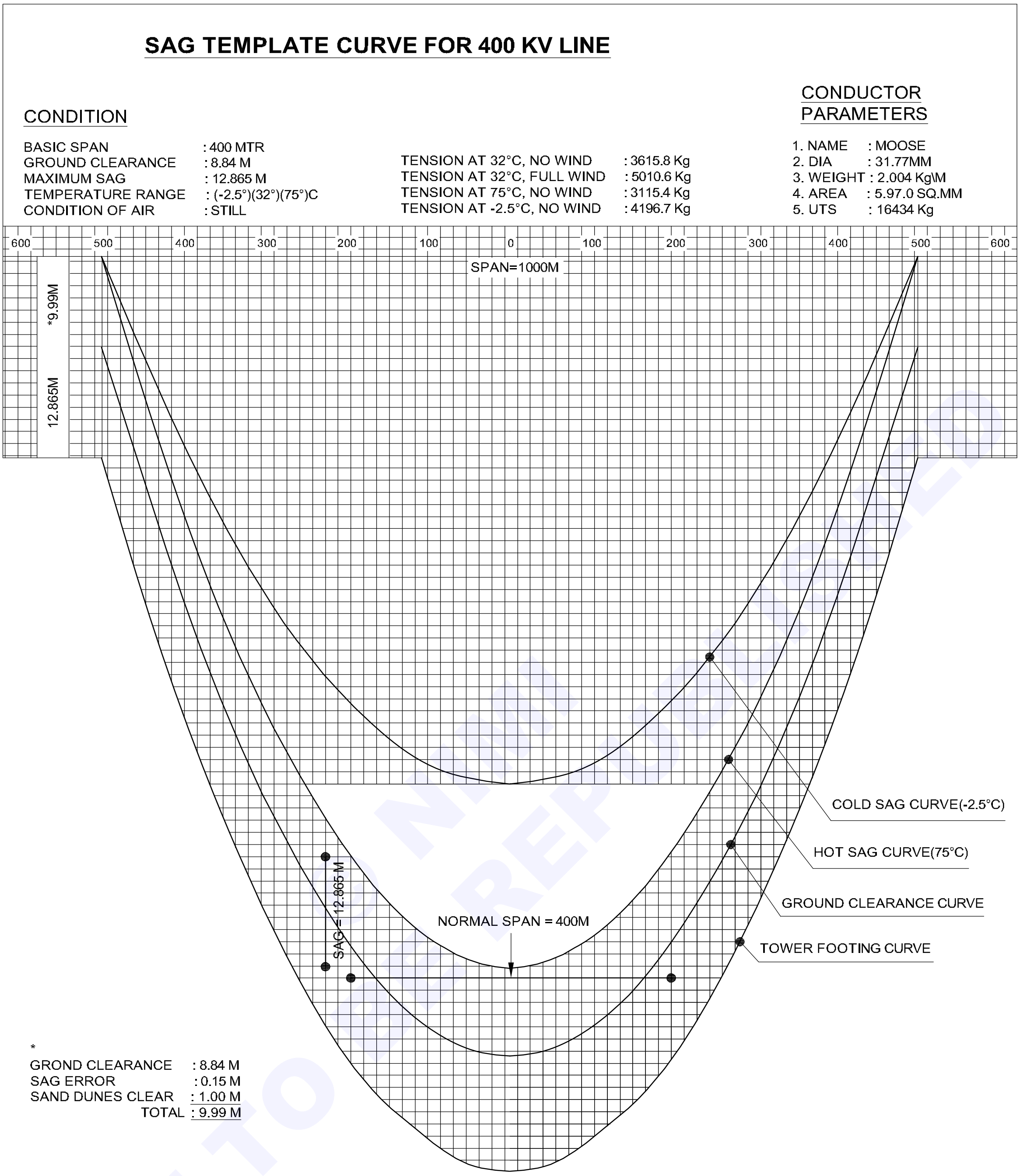
The sag of different spans is calculated by the following formula:

Sag at any Span = Sag at Basic Span × (Span Length) ^{2}/ (Basic Span) ^{2}

The sags for spans ranging from 20 metres to 1000 metres are calculated separately for maximum and minimum temperature conditions. The sag curves are then plotted on a transparent graph paper with

the same scale as used for plotting the profile, i.e., 1 cm = 20 metres for span length (horizontal) and 1cm = 2 metres for sag (vertical)

Fig 2



SU20N210108H2

Conduct final location survey

Objectives: At the end of this exercise you shall be able to
- **draw simple location survey of the given drawing**
- **draw the final location survey given drawing**
- **draw application of sag template on profile**
- **prepare final drawing of plan and profile.**

Requirements

Tools/Instruments

- Theodolite/with tripod - 1 No.
- Drawing board with drafting machine - 1 No.
- 30 cm scale - 1 No.
- Sets square (45° & 60°) - 1 Set
- Instrument box - 1 No.

Materials

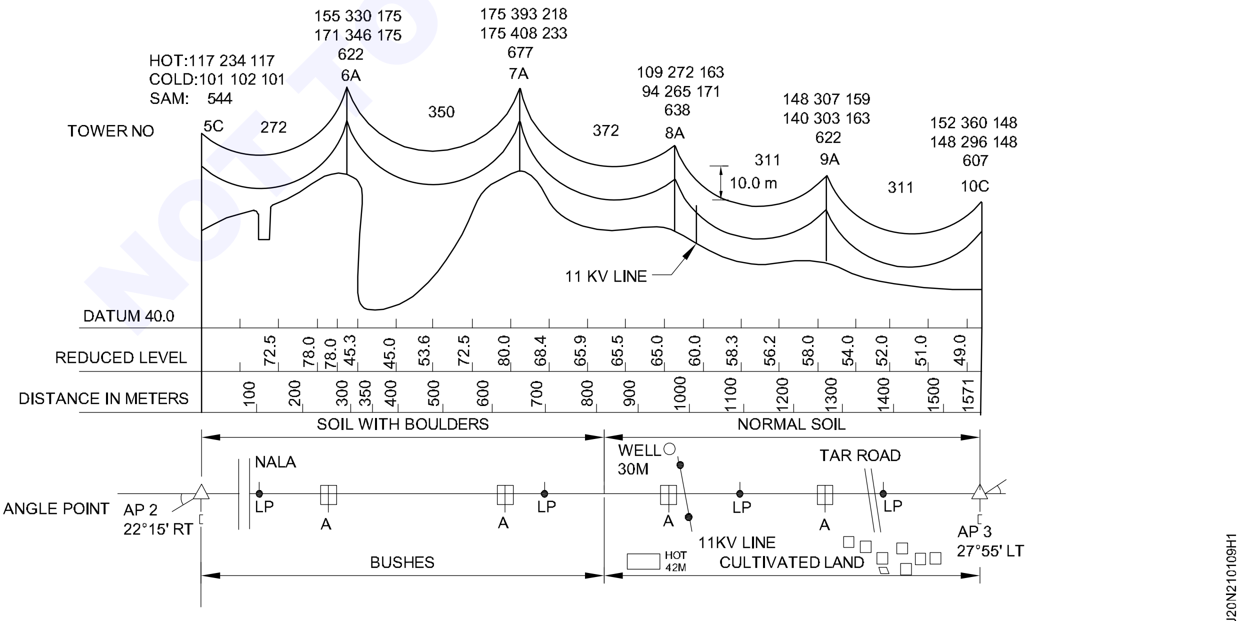
- A2 size drawing paper - 1 No.
- Eraser - 1 No.
- Pencils H & HB - 1 No. each
- Cello tape - as reqd.

PROCEDURE

Route marking (Fig 1)

- At the starting point, every 1.25 km and at the end point concrete pillars 200 x 200 mm square and height 300 mm shall be buried in the field.
- Mark the name of the project/identification marks on them.
- A wooden peg of size 50 x 50 mm and length 150 mm is embedded in the center of the concrete pillars
- Wooden pegs of size 50 x 50 mm and length 150 mm driven in the ground between the angle points at prominent positions along the route
- The pegs and pillars should be driven firmly into the ground with the top at 50 mm below the ground level. Nails of 25 mm length shall be fixed on the top
- The theodolite survey is started from the known fixed angle point in the direction of given line deviation and continued upto a distance equal to the section length between the starting point and the next angle point.
- The wooden pegs placed are checked. Intermediate checks are also made by measuring offsets from the line to well defined objects

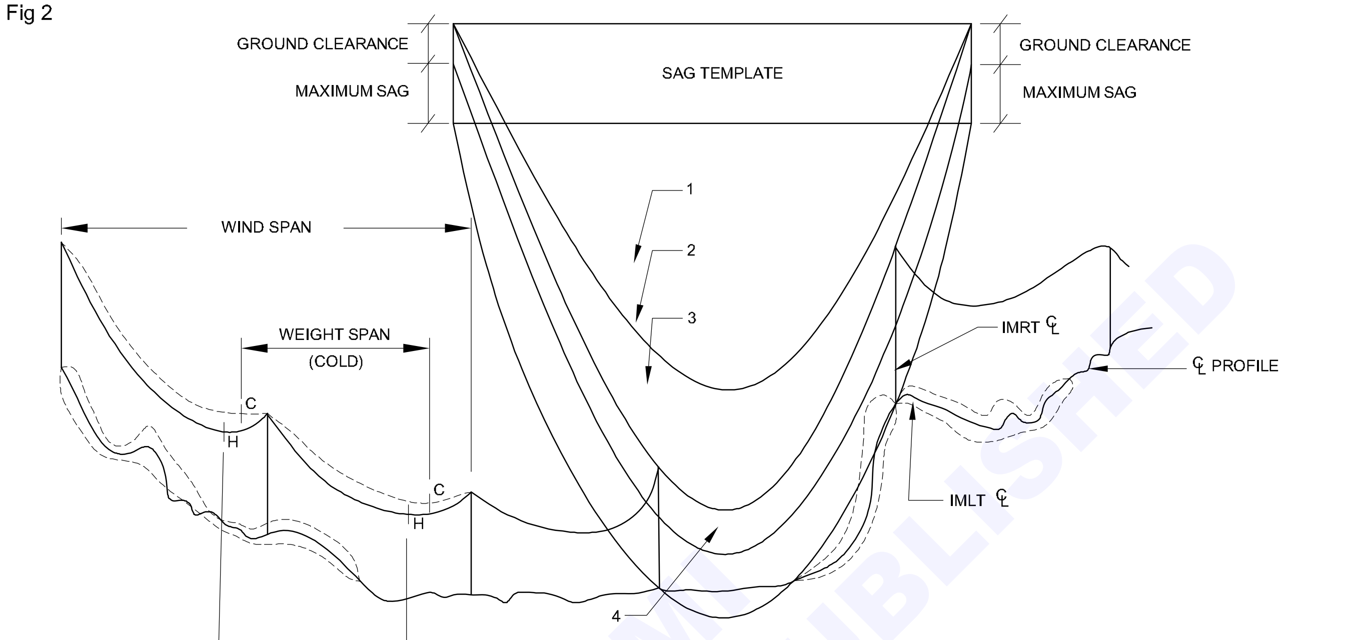
Fig 1



TYPICAL SKETCH OF PROFILE

- The line alignment is continued to the next deviation angle and the next section length as per the profile.
- This process is continued till an angle point is reached which is found fixed in the field either by permanent pillar or by means of identification marks given in the profile.
- Once the angle points are marked, correct angles of deviation and section lengths are measured and noted on the profile.
- A number of alignment pegs are given during the exact distance measurement of the section lengths. (Fig 2)

Fig 2



1 REPRESENTS COLD TEMPLATE OR UPLIFT CURVE

2 REPRESENTS HOT TEMPLATE OR MAXIMUM SAG CURVE

3 REPRESENTS GROUND CLEARENCE CURVE

4 REPRESENTS TOWER FOOTING CURVE

IMRT CENTRAL LINE REPRESENTS RIGHT OFFSET LEVEL

IMLT CENTRAL LINE REPRESENTS LEFT OFFSET LEVEL

APPLICATION OF SAG TEMPLATE ON PROFILE

— — — — — —

Mark tower foundation pit point (as per type of tower)

Objectives: At the end of this exercise you shall be able to
- **state spotting and peg marking of tower location**
- **excavation pit marking**
- **typical excavation pet marking.**

Requirements

Tools/Instruments

- Drawing board with drafting machine - 1 No.
- Metric scale 30 cm - 1 Set
- Sets square (45° & 60°) - 1 Set
- Instrument box - 1 No.

Materials

- A2 size drawing paper - 2 Nos.
- Eraser - 1 No.
- Pencils H & HB - 1 No.each
- Cello tape - as reqd.

Mark tower foundation pit points

Foundation of the location is carried out. This is based on the specific foundation drawing of the type and make of the tower which is to be erected at that location. The tower legs, footings and faces are designated as shown in the drawing below. (Figs 1 & 2)

Fig 1

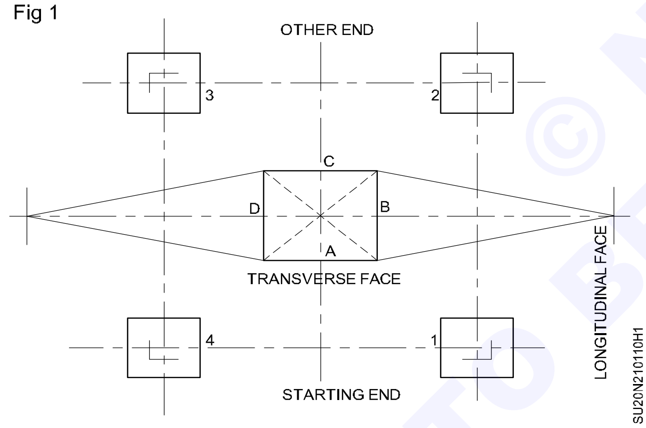
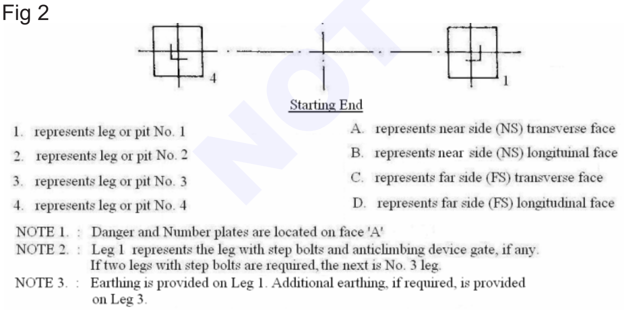


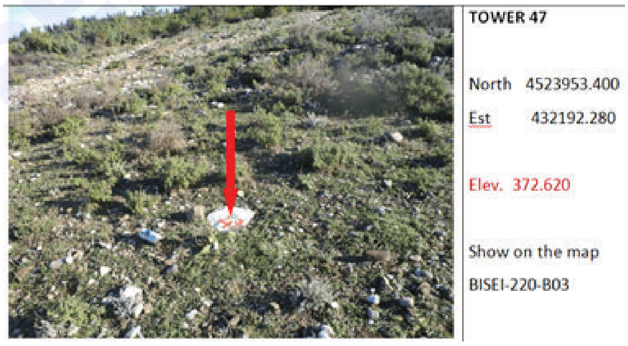
Fig 2



The pit marking shall be carried out according to the pit marking drawing which is prepared from the foundation drawing of the tower. The size of the pit, in case of open cut foundations, is worked out by adding 150 mm to the sides of the base pad on all the four sides for allowing working space. No margin is necessary in case of undercut foundations.

The excavation pit marking drawing indicates the distance of centres, sides and corners of the pits with reference to the centre point of the tower. These distances are measured and each pit boundary is marked in the field by means of spade or pick axe along the sides of the pit. (Fig 3)

Fig 3



A typical excavation pit marking drawing is given

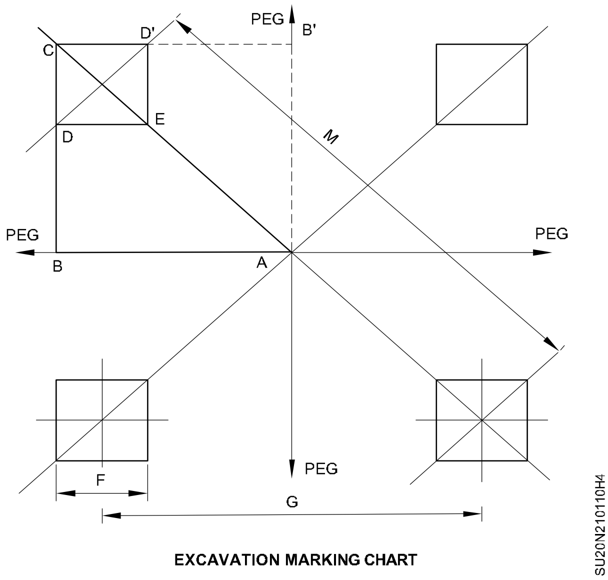
Designation of Tower Legs, Footing and Face

EXCAVATION MARKING CHART (Fig 4)

From the dimensions shown in the drawing, the triangle ABC is first marked with the help of a measuring tape. The distance CD, equal to F (width of the pit) is marked on the ground. The triangle AB'C is then marked by shifting the point B and without changing the points A and C. The distance CD', equal to F, is then marked. The sides DE and D'E, both equal to F, are then marked. The procedure is repeated for marking the other three pits.1.7 The dimension G shown in the drawing is the centre to centre distance between stubs of the tower at their lowest point. The dimension M is the diagonal distance between the ends of the stubs of the tower.

The excavation pit marking drawing is prepared on the basis of these dimensions.

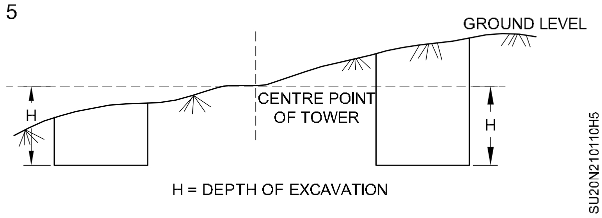
Fig 4



EXCAVATION MARKING CHART

The depth of actual excavation at the pit centre is measured with reference to the ground level at the centre of the tower location. A typical example of determining the actual depth of excavation of the pits is shown below. (Fig 5)

Fig 5



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Justify to construct a new railway line

Objectives: At the end of this exercise you shall be able to
- **stages in surveying for new railway line**
- **viability of new railway line construction**
- **final alignment of survey**
- **final survey report.**

Requirements

Tools/Instruments
- Prismatic compass
- Levelling instruments
- Levelling staff
- Ranging rods
- Arrows

Materials
- Field note book
- Pencil
- Eraser

PROCEDURE

TASK 1: **Stages in surveying for new railway line**

1 Validation of new railway line construction.

2 Marking of tentative alignments.

3 Reconnaissance survey.

4 Selection of good alignments.

5 Preliminary survey of alignments.

6 Final alignment survey.

7 Final survey report.

Viability of new railway line construction

1 Consider some important point which justify viability of railway line.

2 Marking of tentative alignments.

3 Do reconnaissance survey and preliminary survey of alignment.

4 Calculation of good alignments.

5 The total number of people living in the area across which a railway line is proposed are taken into record.

6 The population habits and living standards, economic conditions are observed to make sure that the department will earn revenue by this line.

7 To record the number of bridges, culverts, tunnels etc., a topographical map of that area should be studied.

8 To understand alignment and gradients, contour map of that area should be studied.

9 To connect all the industries by railway line, industrial map of that area should be studied.

10 New railway line laid should not affect the valuable land in agriculture so, agricultural map should also be studied.

11 Presence of agricultural, natural, industrial resources should be recorded.

12 Presence of religious places, business centers, markets etc., should be noted.

13 An estimate should be made on amount of revenue that may accumulate from passengers, goods, etc.,

Final survey alignment (Fig 1)

Fig 1

After completion of preliminary survey, final alignment among all good alignments is selected. This is purely based on the economy and final alignment is economical than the others. But before its approval a final location survey is conducted for one final time which involves the following steps.

1 Masonry pillars are constructed along the center line of alignment with an interval of 1000m. The pillar position can define the width required for railway track. In between these, pegs are provided with an interval of 30m.

2 Station yards are marked at required points.

3 Level crossings, culverts etc., are marked.

4 Bridge provision places are marked with these pillars.

5 Intersection points and tangent points of curve are marked.

6 Compensation of properties is estimated for the final time and marked those places.

Final survey report (Fig 2)

Fig 2

When final survey alignment is completed then a report is prepared for the final alignment and it is submitted for approval. The report includes

1 Project introduction

2 Necessity of project

3 Justification of final alignment

4 Details of final alignment like its length, area, number of bridges, culverts, crossings etc.

5 Estimation sheet

6 Specification details

7 Revenue expected

8 Recommendation of project

Along with the report some maps with suitable scale are to be attached and they are

- Map of the area through which alignment will pass
- Route survey map
- Longitudinal section of alignment
- Cross section of alignment
- Map of station yards
- Drawings of culverts, bridges, tunnels, etc., to be constructed along the alignment.
- Drawings of station buildings, yards etc.,

Marking of tentative alignment

Objectives: At the end of this exercise you shall be able to
- **mark different alignment**
- **select a good alignment.**

Requirements

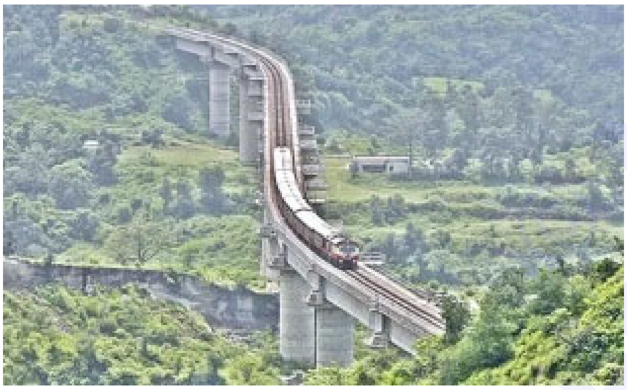
Tools/Instruments
- Prismatic compass
- Levelling instruments
- Levelling staff
- Ranging rods
- Arrows

Materials
- Field note book
- Pencil
- Eraser

PROCEDURE

TASK 1: **Marking of tentative alignment (Fig 1)**

Fig 1



1 Mark the alignment should be as short as possible.

2 The alignment should not pass through high value lands like through centre of village or cities valuable structure etc.,

3 The alignment should be as straight as possible.

4 Minimize the number of curves.

5 Mark the alignment on ridge lines to eliminate the earth filling.

6 Avoid there is any valley or depressions.

7 Alignment should not pass through religion places, temples, churches, mosques, burial ground etc.,

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TASK 2: **Selection of good alignment (Fig 1)**

Fig 1

1 A good alignment is always short and economical.

2 A good alignment generate considerable amount of revenue.

3 A good alignment consists of minimum number of bridges or culverts in its way.

4 Earth filling or earth excavation is as minimum as possible along good alignment.

5 Eliminate vertical curve in alignment.

6 Connect all the important and rush areas in that region.

7 Locate the station yards which should be easily reachable for passengers.

Conduct reconnaissance-preliminary survey and select good alignment

Objectives: At the end of this exercise you shall be able to
- **draw zig zag line alignment**
- **switch back alignment**
- **spiral or complete loop alignment.**

Requirements

Tools/Instruments

• Drawing board with drafting machine	- 1 No.	• Eraser	- 1 No.
• 30 cm scale	- 1 No.	• Pencils H & HB	- 1 No. each
• Sets square (45° & 30°)	- 1 Set	• Cello tape	- as reqd.
• Instrument box	- 1 No.	• Duster cloth	

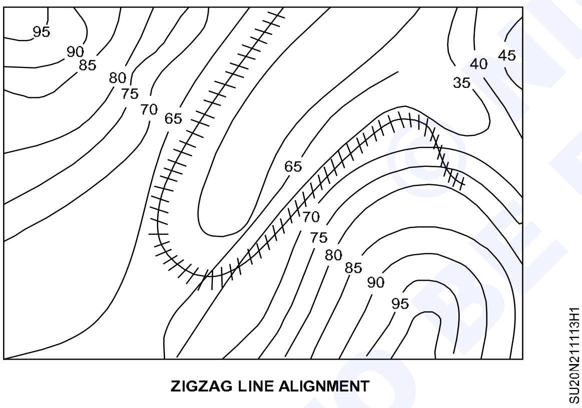
Materials

- A2 size drawing sheet - 1 No.

PROCEDURE

TASK 1: **Draw the zig zag line alignment as shown in fig 1.**

Fig 1



ZIGZAG LINE ALIGNMENT

1 Carefully study the contour map of the area where the railway line is to be constructed.

2 Based on the study of the contour map, identify a possible route for the railway line. Consider factor such as the steepness of the terrain, use presence of rivers or other obstacles and the proximity to existing infrastructure such as roads and buildings.

3 Calculate the maximum gradient the railway line can have, based on the type of train that will be using the line.

4 Plan the alignment of railway line, taking into account the maximum gradient and the terrain. In general, the line should be aligned in a series of curves that follows the contour of the terrain.

5 Determine the radius of the curves in the alignment. This will depend as the maximum speed of the train that will be using the line, as well as the gradient of the terrain.

6 Based on the radius of the curves, calculate the length of each curve in the alignment.

7 Using the calculated radius of length of the curves, draw the zig zag alignment of the railway line on the contour map. Label the curves with their radii of lengths.

8 Review the alignment of make any necessary adjustment to ensure that it is safe and efficient for train operations.

- In zig zag line method the railway line traverse in a zig zag alignment of and follows a convenient side slope which is nearly right angles to the general direction of the alignment. The line turns 180° in a horse shoe pattern to gain height.

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TASK 2: **Switch back alignment as shown in fig 1.**

1 Determine the starting and ending points of the railway line: Before you can draw the switch back alignment, you need to know where the railway line starts and where it ends. Look for any information or markers on the contour map that can help you identify these points.

2 Identify the maximum allowable grade and radius of the curve: The maximum allowable grade is the steepest slope that a train can safely travel on. The radius of the curve is the distance between the center of the curve and the track. These values will help you

determine how many switchbacks you need and how steep they can be.

3 Determine the location and number of switchbacks: Switchbacks are necessary to climb steep hills or mountains. They involve a series of curves that allow a train to change direction and gain elevation. You need to determine the location and number of switchbacks based on the maximum allowable grade and radius of the curve.

4 The length of each switchback will depend on the elevation gain and the maximum allowable grade. You can calculate the length by dividing the elevation gain by the maximum allowable grade.

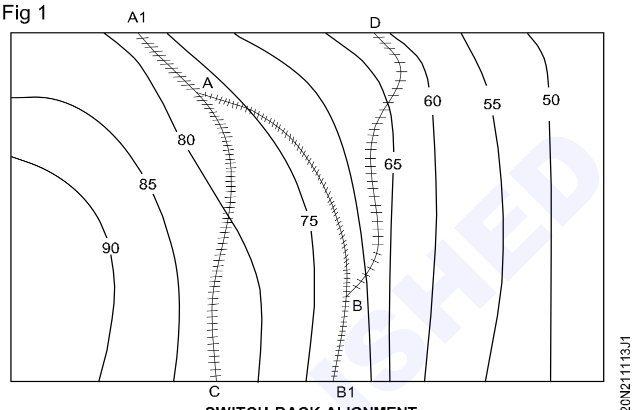
5 Using a pencil and ruler, draw the switchback alignment on the contour map. Start with the first switchback and work your way up the hill or mountain. Remember to follow the maximum allowable grade and radius of the curve.

6 Once you have the basic switchback alignment drawn, you can add more details such as track width, turnouts, and signals.

7 Check your work to make sure that the switchback alignment is feasible and meets safety standards. Revise the alignment as necessary to make improvements.

- In the case of steep side slopes, a considerable gain in elevation is accomplished by the switch-back method (Fig 1). This method involves a reversal of direction achieved by a switch, for which the train has to necessarily stop. The switch point is normally located in a station yard. In Fig.2, A and B are two switches and A1 and B1 are two buffer stops. A train coming from D will stop at B1 and move in back gear to line BA. It will stop at A1 again and then follow the line AC.

Fig 1



SWITCH-BACK ALIGNMENT

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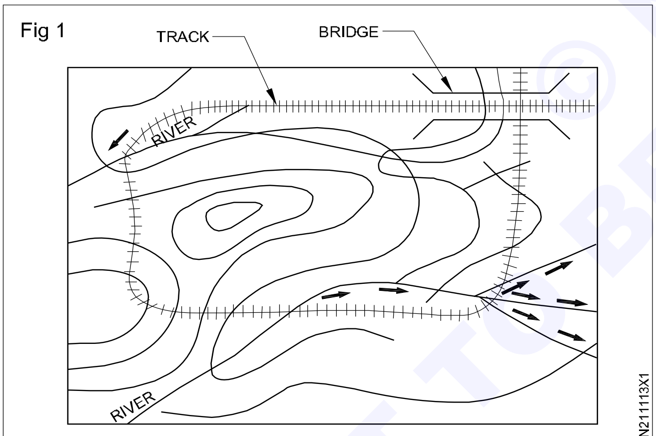
TASK 3: **Spiral or complete loop alignment. (Fig 1)**

Fig 1



SPIRAL or COMPLETE LOOP METHOD

1 This method is used in a narrow valley where a small bridge or viaduct has been constructed at a considerable height to span the valley (Fig 1).

2 In this case, normally a complete loop of the railway line is constructed, so that the line crosses the same point a second time at a height through a flyover or a tunnel.

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Conduct detail survey, prepare a drawing including design of curves with setting out table

Objectives: At the end of this exercise you shall be able to
- **conduct detail survey**
- **data to be collected for the detail survey**
- **survey drawings and project reports**
- **draw simple curve using deflection angle method**
- **draw the curve using perpendicular offsets from tangent.**

Requirements

Tools/Instruments

- Theodolite with tripod - 1 No.
- Dumpy level with tripod - 1 No.
- 30 cm scale - 1 No.
- Sets square (45° & 30°) - 1 Set
- Instrument box - 1 No.
- Metric chain - 1 No.

Materials

- A2 size drawing sheet - 1 No.
- Eraser - 1 No.
- Pencils H & HB - 1 No. each
- Cello tape - as required
- Duster cloth

The choice of survey instruments will largely depend upon the character of regions. In recent times various electronic survey instruments like Total Survey Station are used for collecting all types of survey data. This survey projects can be processed by use of computer softwares for preparation of various design drawings.

PROCEDURE

TASK 1: **Conduct detailed survey**

1 The centre line of the alignment is marked on the ground by means of fixing about 15 cm long pegs at every 30 metres interval and about 60 cm stout pegs at every 300 metres chainage. All the points, where a change in direction occurs, tangent points of the curve and also the intersection points, are distinctly marked on the ground. Masonry pillars are built around gaps at the tangents points and at around 1500 m chainage. A number of bench marks are established at chainage less than 800 metres to ease the process of checking of levels and to provide gradients. The levels are also marked on the pillars surrounding the pegs, known as reference pillars.

2 The centre line of waterways of culverts, starting and ending points of bridges, the centre line of tunnel, and position of station buildings, station yards, signal cabins, etc., should be clearly marked, on the ground.

3 The demarcating lines of the alignment, according to land width, site of stations, yards etc., should also be marked.

4 Levelling is done along the alignment with the help of precise levels at 30 m, and cross-section are taken at 90 m interval but at closer intervals in case of steep slopes. Longitudinal and cross levelling is done to ascertain the final gradients of alignment.

5 The magnetic bearings of each tangent should be taken at every curve in case of flat-country terrain.

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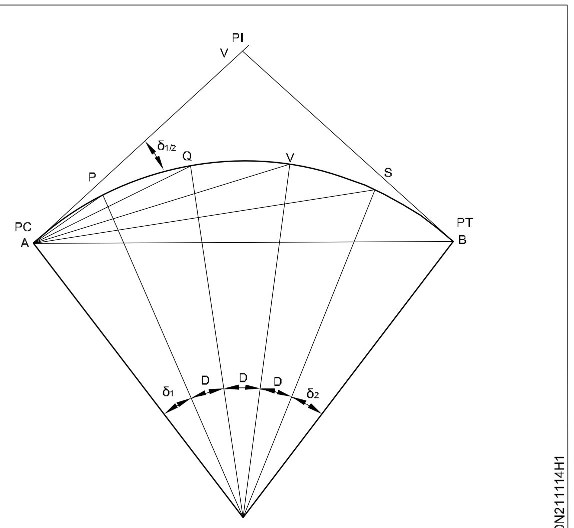
TASK 2: **Draw the simple circular curve using deflection angle method (Fig 1)**

Fig 1



DEFIECTION ANGLES OM A SIMPLE CIRCULAR CURVE

Refer setting out simple curve by (Two Theodolite) Instrument method of Exercise No.2.3.78

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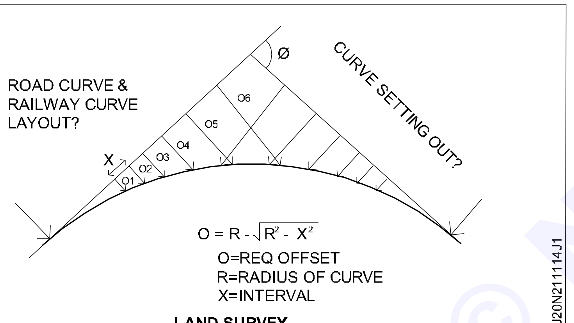
TASK 3: **Draw the curve using perpendicular effects from Tangent (Fig 2)**

Fig 1



LAND SURVEY

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Conduct final location survey

Objectives: At the end of this exercise you shall be able to
- **conduct final location survey**
- **prepare project report.**

PROCEDURE

TASK1: **Final Location Survey**

Once a decision has been taken for a particular railway line to be constructed, a final location survey is done. The instruments used are generally the same as in the case of the preliminary survey. Final location survey is done to prepare working details and make accurate cost estimates in certain cases. The principal differences between the preliminary survey and the final survey are as follows.

a In the final location survey, the alignment is fully staked with the help of a theodolite, whereas it is not obligatory to do so in the case of preliminary survey.

b In the final location survey, a more detailed project report is prepared and submitted.

c All working drawings are prepared in the final location survey.

The following tasks are carried out in the final location survey.

a The centre line is fully marked by pegs at 20 m. At each 100 m, a large peg should be used.

b Masonry pillars are built at tangent points of curves and along the centre line at intervals of 500 m.

c Longitudinal and cross levelling is done to ascertain the final gradient of the alignment. All gradients are compensated for curves.

d The sites for station yards are fully demarcated.

In the final location survey, the following set of drawings is prepared.

a General map of the country traversed by the project at a scale of about 20 km to 1 cm

b Index map, scale about 2.5 km to 1 cm

c Index plan and sections

d Detailed plans and sections

e Plans and cross section

f Plans of station yards

g Detailed drawings of structures

h Plans of junction arrangements

Objectives

The following board objectives should be kept in mind when selecting the best possible alignment in the final location survey.

a Correct obligatory points

b Easy grades and flat curves

c Minimum cost of construction

d Minimum adverse effect on environment

e Ease of construction

f Potential for high speeds

g Avoidance of constraints for future expansion

h Minimum maintenance cost

— — — — — — — —

TASK2: **Project Report**

A final project report is prepared based on the final location survey. The report consists of the following.

1 Introduction

In this segment of the report, the following details are covered.

i Object of investigation and background

ii Programme and methodology of investigation

iii Special features of investigation

2 Characteristics of the Project Areas

In this segment the topographical outline of the areas and geographical features of the country are given to the extent to which these are likely to affect the alignment, probable stability of the line, cost of construction, working expenses, or future prospects of the proposed line. Climatic and rainfall characteristics and environmental characteristics such as the presence of corrosive factors, pollution, etc., which may have an effect on the design and maintenance of structures and bridges, are also brought out.

Standard of Construction

This segment gives details of the following.

Gauge: The gauge adopted for the proposed line and the reasons, if any, for adopting it.

Category of line: The category of the line, the maximum speed potential of the line, the maximum axle load, the loading standard of bridges, and the basis for adopting the same.

Ruling gradient: The gradient adopted and the basis for its selection.

Curves The sharpest degree of curvature adopted, the basis for its adoption, and its impact on the projected speed compatible to the category of line.

Permanent way The rail section adopted, the decision as to whether welding of the rails will be carried out or not, and the type and density of sleepers provided in the project estimate.

Ballast The type and depth of ballast cushion provided.

Stations Spacing of stations in the case of new lines, provision for future intermediate stations, and the scale of facilities contemplated at stations.

Signalling and telecommunication The standard of signalling adopted and the scale of communication facilities provided.

Traction The type of traction proposed

Other details Road crossings, station machinery, residential accommodation, service and maintenance facilities, etc.

Route Selection

This segment provides relevant information and data related to the various alternative routes examined and gives an insight into the factors influencing the choice of the route adopted for the project.

Project Engineering

This section furnishes information and data for the project manager to enable him to understand the scope and extent of the project and to assist him in formulating the strategy for the execution and management of the project. It must focus on the problems likely to be encountered, identify the areas requiring special attention, and place the knowledge and information gathered at the investigation stage for evolving optimal solutions.

Estimation of Cost and Construction Schedule

This segment gives a cost estimate of preliminary expenses, land, formation, bridges, permanent way, station building and residential quarters, road crossings, station equipment, signaling and interlocking, rolling stock, etc. The schedule of' construction as well as investment is also given. A network should be developed for projects costing above Rs.5 million.

Project Organization

This section details the organizational structure for the execution of the project, the proposed headquarters of the project manager and other construction officers, as well as the allocation of the various construction activities. Health and hygienic conditions provided to the staff as well as the provision of necessary medical establishments may be indicated, along with suggested plans providing for the housing of staff and labour and the construction of temporary office buildings. Comments regarding the availability of water for construction purposes and its suitability for drinking purposes may also be given. The purpose and final cost allocation of such plans may also be indicated.

Tabulated Details

The report is accompanied by tabulated details of curve abstract, gradient abstract, bridge abstract, important bridges, stations, machinery, stations, and station sites.

Arrangement of Documents in the Report

All the documents pertaining to a final location survey report should be in the following order.

1 Covering note

2 Index

3 Report

4 A list of drawings accompanying the report

5 Appendices to the report

   a Historical and geographical aspects

   b Location report

   c Rates for construction work

Draw a double storied residential building, plan, elevation, cross section and details of foundation

Objectives: At the end of this exercise you shall be able to
- **draw the ground floor and first floor plan**
- **draw the sectional elevation of ABCD**
- **draw the cross section of EF**
- **draw foundation details**
- **draw site plan and layout plan.**

PROCEDURE

TASK 1: **Draw the ground floor and first floor plan as per the given sketch**

— — — — — — — —

TASK 2: **Draw the sectional elevation of ABCD as per the given sketch**

— — — — — — — —

TASK 3: **Draw the cross section of EF as per the given sketch**

— — — — — — — —

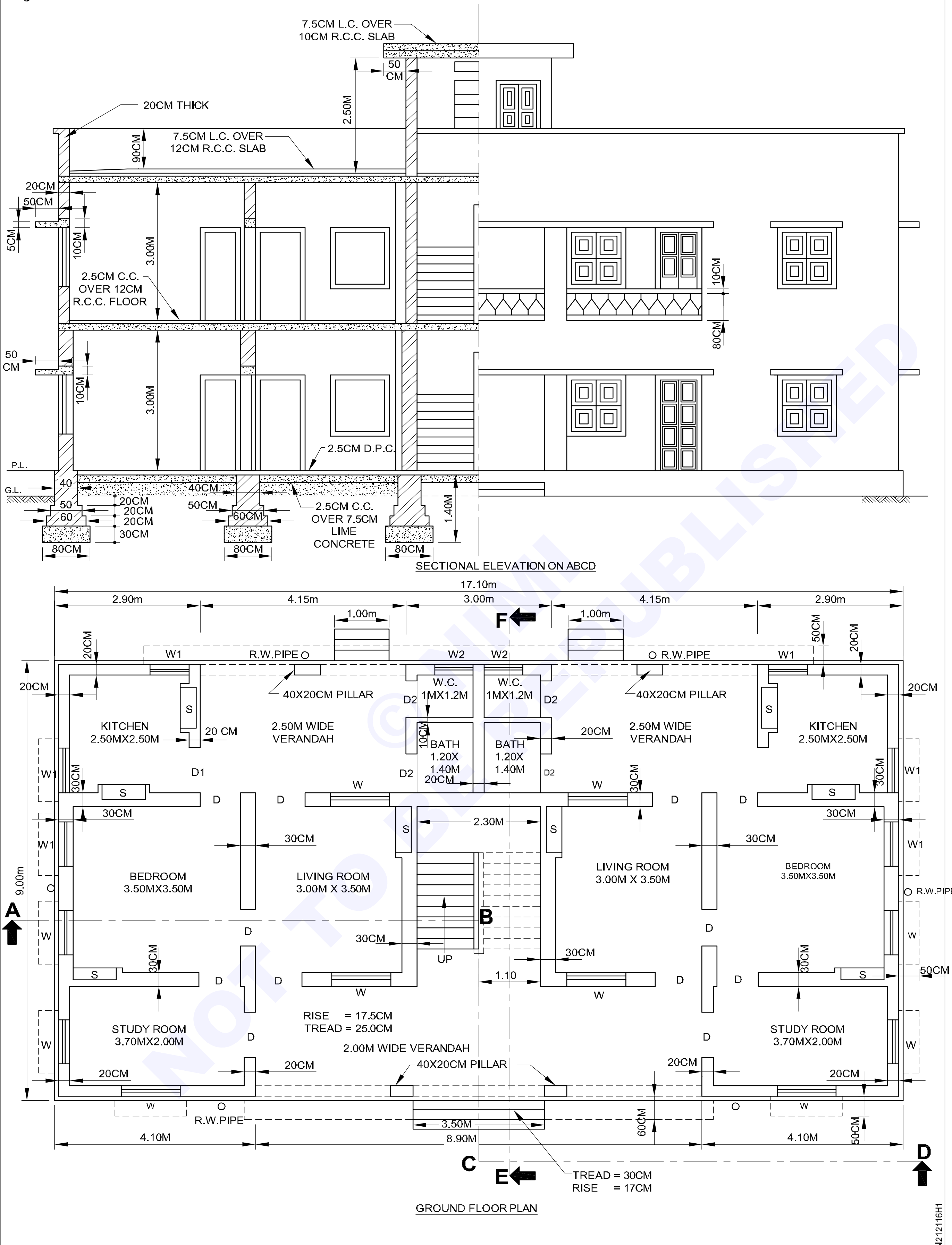
TASK 4: **Draw the detail of foundation**

— — — — — — — —

TASK 5: **Draw site plan and layout plan**

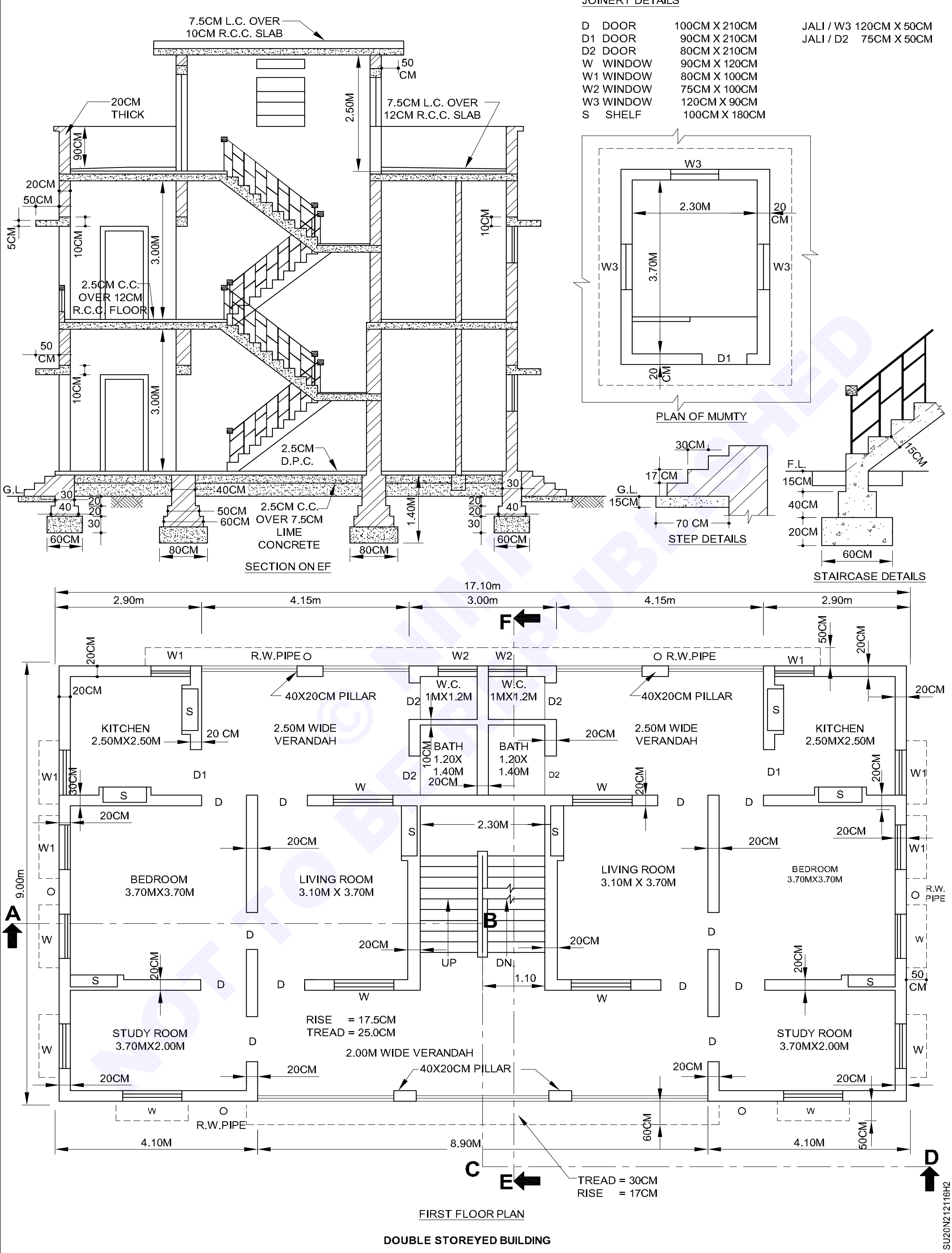
— — — — — — — —

Fig 1



DOUBLE STOREYED BUILDING

Fig 2



JOINERY DETAILS
D DOOR 100CM X 210CM
D1 DOOR 90CM X 210CM
D2 DOOR 80CM X 210CM
W WINDOW 90CM X 120CM
W1 WINDOW 80CM X 100CM
W2 WINDOW 75CM X 100CM
W3 WINDOW 120CM X 90CM
S SHELF 100CM X 180CM
JALI / W3 120CM X 50CM
JALI / D2 75CM X 50CM
7.5CM L.C. OVER 10CM R.C.C. SLAB
7.5CM L.C. OVER 12CM R.C.C. SLAB
20CM THICK
2.5CM C.C. OVER 12CM R.C.C. FLOOR
2.5CM D.P.C.
2.5CM C.C. OVER 7.5CM LIME CONCRETE
G.L.
SECTION ON EF
PLAN OF MUMTY
STEP DETAILS
STAIRCASE DETAILS
F.L.
KITCHEN 2.50MX2.50M
2.50M WIDE VERANDAH
40X20CM PILLAR
R.W.PIPE
W.C. 1MX1.2M
BATH 1.20X 1.40M
BEDROOM 3.70MX3.70M
LIVING ROOM 3.10M X 3.70M
STUDY ROOM 3.70MX2.00M
RISE = 17.5CM
TREAD = 25.0CM
2.00M WIDE VERANDAH
TREAD = 30CM
RISE = 17CM
UP
DN
17.10m
9.00m
FIRST FLOOR PLAN
DOUBLE STOREYED BUILDING
SU20N212116H2

Prepared a detailed estimate of double storied residential building

Objectives: At the end of this exercise you shall be able to
- **prepare detailed estimate of ground floor**
- **prepare detailed estimate of first floor**
- **prepare detailed estimate of second floor**
- **prepare abstract estimate of first floor**
- **prepare rate analyze.**

PROCEDURE

TASK 1: **Prepare the detailed estimate of double storied residential building consisting two quarters in each storey from the given drawing and general specification. Prepare the estimate of ground and first floor.**

Ground floor centre to centre length of walls

Main rooms

Back long walls of all rooms including staircase room C. to C length

= 2 (3.50 + 3.00) + 2.30 +(4 x 0.30)+(0.30/2)+(0.30/2 = 16.80m

Front long wall of bed and living room on one side of stair case room C to C length

= 3.50 + 3.00 + 0.30 +(0.30/2)+(0.30/2) = 7.10m

Cross or short wall C. to C length

= 3.50 + 0.30/2 + 0.30/2 = 3.80m

Front Verandah

Study room, front long wall C to C length

= 3.70 + (0.20/2) + (0.20/2) = 3.90m

Study room cross or short wall C to C length

= 2.00 + (0.30/2) + (0.20/2) = 2.25m

Verandah wall in between study rooms C to C length

= 8.90 + 0.20/2 + 0.20/2 = 9.10m

Back Verandah

Kitchen, back wall C to C length

= 2.50 +(0.20/2)+(0.20/2) = 2.70m

Kitchen, cross or short wall C to C length

= 2.50 + (0.30/2) + (0.20/2) = 2.75m

Bath and W.C. two sets combined, back long wall C to C length

= (2 x 1.20) + 0.20 + 2 x (0.20/2) = 2.80m

Bath and W.C cross or short wall C to C length

= 1.40 + 1.00 + 0.10 + (0.30/2) + (0.20/2) = 2.75m

Verandah wall in between kitchen and W.C. C to C length

= 4.15 + 0.10 + 0.10 + 0.10 = 4.45m

First floor centre to centre length of walls

Main Rooms

Back long wall of all rooms including staircase room C to C length

= (3.70 + 3.10) 2 + 2.30 + (4x0.20) + (0.20/2) + (0.20/2) = 16.90m

Front long wall of bed and living room on one side of staircase room C to C length

= (3.70 + 3.10) + 0.20 + 2 x 0.20/2 = 7.20m

Cross or short walls C to C length

= 3.70 + 0.20/2 = 3.90m

Front Verandah

Study room - Front long wall C to C length

= 3.70 + 2 x (0.20/2) = 3.90m

Study room - Cross or short wall C to C length

= 2.00 + 2 x 0.20/2 = 2.20m

Verandah wall in between study rooms C to C length

= 3.10 + 2.30 + 3.10 + (2 x 0.20) + 2 (0.20/2) = 9.10m

Back Verandah

Kitchen - Back wall C to C length

= 2.50 + 2 (0.20/2) = 2.70m

Kitchen - Cross or short wall C to C length

= 2.50 + 2 x 0.20/2 = 2.70m

Bath and W.C. - Two sets combined, back wall C to C length

= 1.20 + 1.20 + 0.20 + 2 x 0.20/2 = 2.80m

Bath and W.C. cross walls C to C length

= 1.40 + 1.00 + 0.10 + 2 x 0.20/2 = 2.70m.

Verandah wall in between kitchen and W.C.C to C length

= 4.15 + 2 x 0.20/2 = 4.35m

The estimate has been prepared sub-head wise storey by storey, first the ground floor and then the first floor.

DATA

1 Given ground floor plan

2 Given first floor plan

3 Given sectional elevation

4 Given specification

Double storeyed building

Example 1: Prepare a detailed estimate of double storeyed residential building consisting for two roomed quarters (two quarters in each storey) from the given drawings figs 1 and 2 and general specifications. The estimate of ground floor and first floor should be prepared separetely. The estimate of the Mumty room (staircase room in the 2nd floor) should be included in the estimate of the first floor. Assume suitable rates. Workout also plinth area rates of the building.

General specifications

Foundation and plinth

Foundation concrete shall be of lime concrete with over burnt brick ballast. Foundation and plinth masonry shall be of first class brick work in lime mortar.

Damp of proof course

D.P.C shall be provided at the plinth level with 2.5 cm thick layer of C.C of cement coarse sand and stone chips in the proportion of 1:1½:3 mixed with standard water proofing compound.

Super structure

30 cm thick walls of the main rooms in ground floor shall be of first class brick work in lime mortar. All 20 cm thick walls in ground floor and first floor shall be first class brick work with 1:6 cement local sand mortar 10 cm partition walls shall be first class brick work with 1:3 cement coarse sand mortar with hoop iron or equivalent reinforcement every fourth layer.

Roof and floor

Floor of ground floor shall be of 2.5 cm C.C.1:2:4 over 7.5 cm lime concrete. Floor of first floor shall be 2.5 cm C.C.1:2:4 over R.C.C slab. Roof of first floor shall be 7.5 cm lime concrete terracing over R.C.C slab. All R.C.C slab be of C.C.1:2:4 of cement coarse sand, stone chips/ reinforced with 1% reinforcement.

Door and window

Door and window chowkhats shall be of sal wood of 10 cm x 7.5 cm in section. All door and window shutters shall be 3 cm thick Deodar wood. Mumty room window shall be fully glazed with 3 cm thick. Deodar wood, 4 cm R.C.C jalli shall be provided over bath and W.C doors over mumty room glazed windows for ventilation. All windows shall be provided with 20 mm dia bars. Iron hold fasts shall be provided for fixing doors and windows chowkhats.

Plastering

All walls shall be plastered with 12 mm thick 1:6 cement local sand mortar. Ceiling and underside of R.C.C work shall be finished with 6 mm thick 1:3 cement and medium sand mortar. All inside wall shall be provided with 20 cm high skirting with 12 mm thick 1:3 cement, coarse sand mortar, neat cement finished. Dado of 12 mm thick cement, coarse sand 1:3 mortar neat cement frinished shall be provided in kitchen and W.C, upto 50 cm height and in bathroom upto 100 cm height. Steps shall be provided with 20 mm thick plaster with 1:3 cement, coarse sand mortar neat cement finished.

White washing and colour washing

All doors and windows shall be painted two coats over one coat of priming. Back of chowhats shall be painted with two coats of coaltar. Inside walls, ceiling, undersides of sunshades shall be white washed three coats. Outside shall be colour washed two coats over one coat of white washing.

Rain water pipes

6 numbers 100 mm dia. A.C. and water down pipes shall be provided Electrification, water supply and sanitary works.

Provision for internal electrification, water supply and sanitary works shall be provided on percentage basis.

Ground floor

Details of measurement and Calculation of quantities

Item No.	Particulars and items of works	No.	Length m	Breadth m	Height or depth m	Quantity	Explanatory notes
	I. Earthwork						
1	Site clearance and setting out	1	-	-	-	1 Job	
2	**Earthwork in excavation in foundation Main rooms back long wall full length**, length end to end,	1	17.60	0.80	0.90	12.67m³	L = 16.80+0 .80=17.60 m
	Front long walls of bed and living rooms	2	7.90	0.80	0.90	11.38m³	L = 7.10+0.80=7.90 m
	Cross or short walls	6	3.00	0.80	0.90	12.96m³	L = 3.80-0.80=3.00 m
	Study rooms -						
	Front walls (long)	2	4.50	0.60	0.60	3.24m³	L=3.90+0.60=4.50 m
	Cross walls (short)	4	1.55	0.60	0.60	2.23m³	L=2.25-0.60/2 - 0.80/2 = 1.55m
	Kitchen -						
	Back walls (long)	2	3.30	0.60	0.60	2.38m³	L= 2.70 + 0.60=3.30 m
	Cross walls (short).	4	2.05	0.60	0.60	2.95m³	L= 2.75 - 0.60/2 - 0.80/2 = 2.05 m
	Bath and W.C -						
	Back wall (long)	1	3.40	0.60	0.60	1.22m³	L = 2.80 + 0.60 = 3.40 m
	Cross wall (Short)	3	2.05	0.60	0.60	2.21m³	L = 2.75 - 0.60/2 - 0.80/2 = 2.05 m
	Verandah pillars	4	0.80	0.60	0.60	1.15m³	Foundation 80x60 m
	Front ver, pillars dwarf wall sum total length }	1	6.90	0.40	0.40	1.10m³	L=9.10-2 x 0.60/2 - two pillars = 9.10 - 0.60 2 x 0.80 = 6.90 m
	Back verandah plinth dwarf walls	2	2.95	0.40	0.40	0.94m³	L=4.35-2x.60/2- one pillar = 4.35-.60-.80= 2.95 m
	Staircase base	1	1.10	0.60	0.70	0.46m³	
	Step front	1	2.50	0.70	0.25	0.44m³	L=2.30+.10+.10=2.50 m
	Step back	2	1.20	0.70	0.25	0.42m³	L= 1.00 +.10+.10=1.20 m
					Total	55.75m³	
3	**Earthwork in filling** in plinth bedrooms	2	3.40	3.40	0.425	9.82m³	Ht.=50-7.5=42.5 cm = 0.425 m
	Living rooms	2	2.90	3.40	0.425	8.38m³	
	Study rooms	2	3.60	1.90	0.425	5.81m³	
	Kitchen	2	2.40	2.40	0.425	4.90m³	
	Bath and W.C	2	1.10	2.40	0.425	2.24m³	
	Verandah front	1	8.80	1.90	0.425	7.11m³	
	Verandah back	2	4.05	2.40	.425	8.26m³	
					Total	46.52cu.m	

4	**II. Concrete - Lime concrete in foundation**						
	Main rooms - Back long wall full length end to end	1	17.60	0.80	0.30	4.22m^3	L. Same as excavation
	Front long walls of bed and living rooms	2	7.90	0.80	0.30	3.79m^3	L. Same as excavation
	Cross short walls	6	3.00	0.80	0.30	4.32m^3	L. Same as excavation
	Study rooms Front long walls	2	4.50	0.60	0.20	1.08m^3	L. Same as excavation
	Cross short walls	4	1.65	0.60	0.20	0.79m^3	L = 2.25-.60/2-.60/2= 1.65 m
	Kitchens Back walls (long)	2	3.30	0.60	0.20	0.79m^3	L.Same as excavation
	Cross walls (short)	4	2.15	0.60	0.20	1.03m^3	L.2.75-.60/2-.6 0/2=2.15m
	Bath and W.Cs. Back walls (long)	1	3.40	0.60	0.20	0.41m^3	L.Same as excavation
	Cross walls (short)	3	2.15	0.60	0.20	0.77m^3	L=2.75-.60/2-.60/2=2.15m
	Verandah pillars	4	0.80	0.60	0.20	0.38m^3	
	Font verandah Plinth dwarf wall	1	7.50	0.40	0.20	0.60m^3	L=9.10-2x.40/2-2x0.60 =7.50 m
	Back verandah plinth dwarf wall	2	3.35	0.40	0.20	0.54m^3	L=4.35-2x.40/2-1x.60 =3.35 m
	Staircase base	1	1.10	0.60	0.20	0.13m^3	
	Step front	1	2.50	0.70	0.15	0.26m^3	
	Step back	2	1.20	0.70	0.15	0.25m^3	
					Total	19.36 cu.m	
5	**R.C.C work 1:2:4 excluding steel reinforcement bars and its bending including centering and shuttering and binding steel**						
	R.C.C slab Bed and living rooms	2	7.40	3.80	0.12	6.749m^3	Bearing - ends full wall (30 cm), sides half wall (15 cm).
	Front verandah including study rooms	1	17.10	2.35	0.10	4.019m^3	Bearing - outer full wall (20 cm), inner half wall (15 cm)
	Back verandah including kitchen, bath and W.C rooms	1	17.10	2.85	0.10	4.874m^3	Total of slab = 15.642 cu.m
	Lintels - Over doors main room	8	1.30	0.30	0.10	0.312m^3	(a) 15 cm bearing
	Over windows W main rooms	8	1.20	0.30	0.10	0.288m^3	(a)
	Over shelves S in 30 cm wall	6	1.30	0.30	0.10	0.234m^3	(a)
					a =	0.0834	

	Over entrance of stair case	1	2.70	0.30	0.20	0.162m³	
	Over doors D study room	2	1.30	0.20	0.10	0.052m³	(b)
	Over doors D_1 kitchen	2	1.20	0.20	0.10	0.048m³	(b)
	Over doors D_2 bath and W.C	4	1.05	0.20	0.10	0.084m³	(b)
	Over windows W study room	4	1.20	0.20	0.10	0.096m³	(b)
	Over windows W_1 kitchen	2	1.10	0.20	0.10	0.044m³	(b) Side windows
	S kitchen	2	1.30	0.20	0.10	0.052m³	(b)
	Over R.C.C. Jalli over door D_2 of Bath and W.C	4	1.05	0.20	0.10	0.084m³ (b)	Total of (a)s= 0.834 cu.m Toal of (b)s = 0.460 cu.m
	Over front verandah 20 cm thick	1	9.20	0.20	0.20	0.368m³	Continuous over pillars
	Over back verandah continuous including window W_1, W_2	1	13.60	0.20	0.15	0.408m³	15 cm thick
	Sunshades Over window W, 4 in main rooms and 4 in study rooms	8	1.20	0.50	0.05	0.240m³	Average 5 cm thick
	Over window W_1 of kitchen	2	1.10	0.50	0.05	0.055m³	Two side windows
	Over front verandah	1	9.20	0.60	0.05	0.276m³	
	Over back verandah continuous including back windows W_1 & W_2	1	13.60	0.50	0.05	0.340m³	Length same' as for lintel Bearing 5 cm.
	Slabs of shelves 25 cm wide 4 cm thick	8x3	1.10	0.25	0.04	0.264m³	Total of sunshades and shelf slabs = 1.175 cu.m
	Staircase -						
	Inclined slabs....	2	2.54	1.10	0.15	0.838m³	$L = \sqrt{2^2 + 1.575^2} = 2.54$ m
	Above wall at base	1	1.10	0.50	0.15	0.083m³	
	Landing slab middle	1	2.60	1.05	0.15	0.410m³	
	Landing slab 1st floor level	1	2.60	0.75	0.15	0.293m³	B = .60+.15=.75 m
	Steps without reinforcement	8 x 2 x 1.10 x $^1/_2$ (.25x.175)				0.385m³	Triangular section
					Total	21.058 cu.m	Total of staircase slabs (excluding base) =1.541 cu.m
6	**2.5 cm C.C 1:2:4 nosing in steps**						
	Staircase steps	9x2	1.10	-	-	19.80m	
	Front steps	3	2.30	-	-	6.90m	
	Back steps	3x2	1.00	-	-	6.00m	
					Total	32.70 m	
7	**R.C. 1:2:4 Newal post 10 cm x 10 cm, 1 m high including reinforcement complete work**	2	-	-	-	2 Nos	
8	**R.C.C 1:2:4 Hand rail in staircase including reinforecement complete work**	2	2.74	-	-	5.48 m	L = 2.54+.20=2.74 m

9	**4 cm thick R.C.C Jalli including reinforcement complete work**	4	0.75	-	0.50	1.50 sq.m	Over door D_2
10	**2.5 cm Damp proof course C.C. 1:1 $^1/_2$:3 with water proofing compound- Main Rooms**						
	Back long wall	1	17.20	0.40	-	6.88m^2	L=16.80+.40=17.20 m
	Front long walls	2	7.50	0.40	-	6.00m^2	L = 7.10+.40=7.50 m
	Cross short walls	6	3.40	0.40	-	8.16m^2	L=3.80-.40=3.40 m
	Study rooms -						
	Front walls (long)	2	4.20	0.30	-	2.52m^2	L=3.90+.30=4.20 m
	Cross walls (short)	4	1.90	0.30	-	2.28m^2	L=2.25-.40/2-.30/2=1.90 m
	Kitchen						
	Back walls (long)	2	3.00	0.30	-	1.80m^2	L=2.70+.30=3.00 m
	Cross walls (short)	4	2.40	0.30	-	2.88m^2	L=2.75-.40/2-.30/2=2.40 m
	Bath and W.C						
	Back walls (long)	1	3.10	0.30	-	0.93m^2	L=2.80+.30=3.10 m
	Cross walls (short)	3	2.40	0.30	-	2.16m^2	L=2.75-.40/2-.30/2=2.40 m
	Verandah pillars	4	0.50	0.30	-	0.60m^2	
					Total	34.21m^2	
	Deduct						
	Door sills main rooms D	8	1.00	0.40	-	3.20m^2	
	Door sills study room D	2	1.00	0.30	-	0.60m^2	
	Door sills kitchen D_1	2	0.90	0.30	-	0.54m^2	
	Door sills Bath & W.C. D_2	4	0.75	0.30	-	0.90m^2	
			Total of deduction			5.24m^2	
				Net	Total	28.97 sq.m	
11	**III. Brick work First class brick work in lime mortar in foundation and plinth main rooms back wall full length**						
	1st Footing	1	17.40	0.60	0.20	2.09m^3	L = 16.80 + 0.60 = 17.40 m
	2nd footing	1	17.30	0.50	0.20	1.73m^3	L = 17.40 - 0.10 = 17.30 m
	Plinth wall	1	17.20	0.40	0.70	4.82m^3	L = 17.30 - 0.10 = 17.20 m
	Front long walls						
	1st footing	2	7.70	0.60	0.20	1.85m^3	L = 7.10+ 0.60 = 7.70 m
	2nd footing	2	7.60	0.50	0.20	1.52m^3	L = 7.70 - 0.10 = 7.60 m
	Plinth wall	2	7.50	0.40	0.70	4.20m^3	L = 7.60 - 0.10 = 7.50 m
	Cross walls						
	1st footing	6	3.20	0.60	0.20	2.30m^3	L = 3.80 - 0.060 = 3.20 m
	2nd footing	6	3.30	0.50	0.20	1.98m^3	L = 3.20 - 0.10 = 3.30 m
	Plinth wall	6	3.40	0.40	0.70	5.71m^3	L = 3.30 - 0.10 = 3.40 m
	Study rooms						
	Front walls						
	Footing	2	4.30	0.4	0.20	0.69m^3	L = 3.90 + 0.40 = 4.30 m
	Plinth walls	2	4.20	0.30	0.70	1.76m^3	L = 4.30 - 0.10 = 4.20 m
	Cross walls						
	Footing	4	1.80	0.40	0.20	0.58m^3	L = 2.25 - 0.50/2 - 0.40/2 = 1.80 m

	Plinth wall	4	1.90	0.30	0.70	1.60m^3	L = 1.80 + 0.10 = 1.90 m
	Kiitchen						
	Back walls						
	Footing	2	3.10	0.40	0.20	0.50m^3	L = 2.70 + 0.40 = 3.10m
	Plinth wall	2	3.00	0.30	0.70	1.26m^3	L = 3.10 + 0.10 = 3.00m
	Cross walls footing	4	2.30	0.40	0.20	0.74m^3	L = 2.75 -. 50/2 - 0.40/2 = 2.30 m
	Plinth wall	4	2.40	0.30	0.70	2.02m^3	L = 2.30 + 0.10 = 2.40 m
	Bath and W.C						
	Back walls						
	Footing	1	3.20	0.40	0.20	0.26m^3	L = 2.80 + 0.40 = 3.20 m
	Plinth wall	1	3.10	0.30	0.70	0.65m^3	L = 3.20 - 0.10 = 3.10 m
	Cross walls						
	Footing	3	2.30	0.40	0.20	0.55m^3	L = 2.75 - 0. 50/2 0.40/2 = 2.30m
	Plinth wall	3	2.40	0.30	0.70	1.51m^3	L = 2.30 + 0.10 = 2.40m
	Verandah pillars						
	Footing	4	0.60	0.40	0.20	0.19m^3	
	Plinth wall	4	0.50	0.30	0.70	0.42m^3	
	Front verandah plinth dwarf wall sum total length	1	7.80	0.20	0.70	1.09m^3	L = 9.10 - 2 x 0.30/2 - 2 x 0.50 = 7.80 m
	Back verandah plinth dwarf wall	2	3.55	0.20	0.70	0.99m^3	L = 4.35 - 2 x 0.30/2 - 1 x 0.50 = 3.55m
	Staircase base	1	1.10	0.50	0.40	0.22m^3	
	Stair front 1st	1	2.30	0.60	0.20	0.28m^3	
	Step front 2nd	1	2.30	0.30	0.15	0.10m^3	
	Step back 1st	2	1.00	0.60	0.20	0.24m^3	
	Step back 2nd	2	1.00	0.30	0.15	0.09m^3	
					Total	41.94 cu.m	
12	**First class brick work in lime mortar in superstructure in 30 cm walls of main rooms**						
	Back wall full length	1	17.10	0.30	3.00	15.39m^3	L = 16.80 + 0.30 = 17.10 m
	Front long walls	2	7.40	0.30	3.00	13.32m^3	L= 7.10 + 0.30 = 7.40 m
	Cross walls	6	3.50	0.30	3.00	18.90m^3	L = 3.80 - 0.30 = 3.50 m
	Staircase room front wall	1	2.30	0.30	0.60	0.42m^3	Above lintel
					Total	48.03 cu.m	
	Deduct						
	Door openings D	10	1.00	0.30	2.10	6.30m^3	
	Window opening W	8	0.90	0.30	1.20	2.59m^3	4 in main rooms and
	Shelves opening	6	1.00	0.20	1.80	2.16m^3	2 in kitchen
	Lintels (30 cm wall)	Same as marked in item 5				0.834m^3	
				Total of deduction		11.884	
					Net Total	36.15 cu.m	

13	**First class brickwork in 1:6 cement local sand mortar in superstructure in 20 cm walls**						
	Study rooms front walls	2	4.10	0.20	3.00	4.92m^3	L=3.90+.20=4.10 m
	Study rooms cross walls	4	2.00	0.20	3.00	4.80m^3	L=2.25-.30/2-.20/2=2.00 m
	Kitchen back walls	2	2.90	0.20	3.00	3.48m^3	L=2.70+.20=2.90 m
	Kitchen cross walls	4	2.50	0.20	3.00	6.00m^3	L=2.75-.30/2-.20/2=2.50m
	Bath and W.C back wall	1	3.00	0.20	3.00	1.80m^3	L=2.80+.20=3.00 m
	Bath & W.C cross wall	3	2.50	0.20	3.00	4.50m^3	L=2.75-.30/2-.20/2=2.50 m
	Verandah pillars	4	0.40	0.20	2.20	0.70m^3	
	Front verandah wall above lintel	1	8.90	0.20	0.60	1.07m^3	Ht.above lintel 60 cm.
	Back verandah walls above lintel	2	4.15	0.20	0.65	1.08m^3	Ht. above lintel 65 cm
					Total	28.35m^3	
	Deduct						
	Door openings D	2	1.00	0.20	2.10	0.84m^3	Study room doors.
	Door openings D1	2	0.90	0.20	2.10	0.756m^3	Kitchen doors
	Door openings D_2	4	0.75	0.20	2.10	1.26m^3	Bath and W.C doors
	Window openings W	4	0.90	0.20	1.20	0.86m^3	Study room windows.
	Window openings W_1	4	0.80	0.20	1.00	0.64m^3	Kitchen windows
	Window openings W_2	2	0.75	0.20	1.00	0.30m^3	W.C. room windows
	R.C. Jalli over doors D_1	4	0.75	0.20	0.50	0.30m^3	
	Shelves opening kitchen	2	1.00	0.10	1.80	0.36m^3	Back of shelves 10 cm
	Lintel (20 cm wall)	Same as marked (b) in item 5					0.46m^3
	Lintel over back wall of W.Cs	1	3.00	0.20	0.15	0.09m^3	
	Lintel over windows W_1 on back walls of kitchen	2	1.15	0.20	0.15	0.07m^3	
				Total	of deduction	5.936m^3	
					Net total	22.414 cu.m	
14	**10 cm thick first class brick work in partition wall in 1:3 cement, coarse sand mortar with hoop iron or 6 mm dia. steel reinforcement every fourth layer**	2	1.20	-	3.00	7.20 sq.m	
15	**IV Wood work - Door and window Sal wood work in chaukhats in doors and windows**						
	Door D(10 cm x 7.5 cm section)	12	5.30	0.10	0.075	0.477m^3	5 cm in insertion into floor
	Door D_1	2	5.20	0.10	0.075	0.078m^3	

	Door D_2	4	5.10	0.10	0.075	0.153m^3	
	Window W	12	4.20	0.10	0.075	0.378m^3	
	Window W_1	4	3.60	0.10	0.075	0.108m^3	
	Window W_2	2	3.50	0.10	0.075	0.053m^3	
					Total	1.247 cu.m	
16	**3 cm thick panelled shutters of Deodar wood in doors and windows**						h = (2.10-0.075)+.015 = 2.04m
	Door D	12	0.88	-	2.04	21.524m^2	15 mm rebate
	Door D_1	2	0.78	-	2.04	3.182m^2	15 mm rebate
	Door D_2	4	0.63	-	2.04	5.141m^2	15 mm rebate
	Window W	12	0.78	-	1.08	10.109m^2	15 mm rebate
	Window W_1	4	0.68	-	0.88	2.394m^2	15 mm rebate
	Window W_2	2	0.63	-	0.88	1.109m^2	15 mm rebate
					Total	43.459 sq.m	
17	**Doors and windows**	Same as in item (16)				43.459 sq.m	May also be taken per no. of fittings of oxydized iron different fittings
	V.Steel and Iron work						
18	**Steel reinforcement bars including bending in**						
	R.C.C work	$-2 \times \left(\frac{0.90+0.30}{2}\right) \times 0.45 = 0.54$				16.226 q	@ 1% of R.C.C work in item 5 excluding steps = 1% of (21.055-.385)= 1/100x20.67 cu.m
19	**Iron work in hold fasts and window bars -**						
	Hold fasts in doors	18 x	6@1kg	each	=	108 kg	6 Nos in each door
	Hold fasts in windows	18 x	4@1kg	each	=	72 kg	4 Nos in each window
	20 mm dia. window bars @ 2.47 kg per m - 12 windows 90 x 120c m (W)	12 x	8x1.20	=	115.20m		8 bars 1.20 m each
	4 Windows 80x100 cm (W_1)	4x	7x1.00	=	28.00m		7 bars 1.00 m each
	2 windows 75x 100 cm (W_2)	2x	6x1.00	=	12.00m		6 bars 1.00 m each
				Total	155.20 m		
			@ 2.47 kg	per m =		383.34 kg	
					Total =	563.34 kg 5.633 q	
20	**Iron grill work in stair case railing two flights (80 cm high)**	1	5.38		0.80	4.304 sq.m	L=2x2.54+.30=5.38 m

	VI.Plastering and Pointing						
21	**12 mm plastering with 1 :6 cement local sand mortar in walls**						Excluding skirting and dado at bottom
	Inside Plastering						
	Bed Rooms	2	14.00	-	2.80	78.40m²	L=Inner perimeter = 14.00 m
	Living rooms	2	13.00	-	2.80	72.80m²	L=Inner perimeter = 13.00 m
	Staircase room	1	11.60	-	2.80	32.48m²	L=Inner perimeter = 11.60 m
	30 cm face of wall below stair case entrance lintel	2	0.30	-	2.00	1.20m²	
	Shelves - Jambs, sills and soffits	6	5.60	0.20	-	6.72m²	L=(1.0+1.8)x2=5.60 m
	Shelves - Jambs, sills and soffits	2	5.60	0.10	-	1.12m²	L=(1.0+1.8)x2=5.60 m
	Study rooms	2	11.40	-	2.80	63.84m²	L=Inner perimeter = 11.40 m
	Kitchens	2	10.00	-	2.50	50.00m²	L=Inner perimeter =10.00m
	Bathrooms	2	5.20	-	2.00	20.80m²	L=(1.4+1.2)x2=5.20 m
	W.C	2	4.40	-	2.50	22.00m²	L=(1.0+1.2)x2=4.40 m
	Front verandah						
	Long wall inner	1	8.90	-	2.80	24.92m²	Openings to be deducted
	Long wall outer above pillar	1	8.90	-	0.80	7.12m²	
	Side walls	2	2.00	-	2.80	11.20m²	
	Back verandah - Long walls inner	2	4.15	-	2.80	23.24m²	
	Long wall outer above pillar	2	4.15	-	0.80	6.64m²	
	Side walls	4	2.50	-	2.80	28.00m²	
	Pillars 3 faces	4	0.80	-	2.00	6.40m²	L = 40 + 20+ 20 = 80 cm
	20 cm face of wall below verandah lintel	6	0.20	-	2.00	2.40m²	Total of Study. Kitchen, Bath and W.C rooms, Verandahs, etc, of 20 cm wall = 268.80 sq.m, above skirting and Dado
					Total	459.28 m²	
	Deduct						
	Door openings D	12	1.00	-	2.10	25.20m²	One face only
	Door openings D_1	2	0.90	-	2.10	3.78m²	One face only
	Door openings D_2	4	0.75	-	2.10	6.30m²	One face only
	Window openings	4	0.90	-	1.20	4.32m²	One face only
	R.C.C Jalli	-	-	-	-	-	No deduction being small
	Staircase entrance openings	2	2.30	-	2.00	9.20m²	
					Total of deuction	48.8sq.m	
					Net total of inside plaster	410.48m²	
	Outside plastering						
	Outer side (including plinth and 10 cm below G.L)	1	52.00	-	3.77	196.79m²	L = Outer perimeter = 2 (17.10 + 9.00) = 52.20 m Ht.= 3.0 + 0.50+0 .05 + 0.10 + 0.12 = 3.77 m
	Deduct						
	Window openings W	8	0.90	-	1.20	8.64m²	One face.
	Window openings W_1	4	0.80	-	1.00	3.20m²	
	Window openings W_2	2	0.75	-	1.00	1.50m²	
	Front verandah openings	1	8.10	-	2.20	17.82m²	L = 8.90 - 2 x 0.40 = 8.10m

	Back verandah openings	2	3.75	-	2.20	16.50m²	L=4.15-.40=3.75 m
	Step front	1	2.30	-	0.65	1.50m²	Ht.=.50+.05+.10=.65 m
	Step back	2	1.00	-	0.65	1.30m²	
				Total of deductions		50.46 m²	
		Net Total of outside plastering				146.33 m²	
		Grand Total of inside and outside plastering = 556.81 sq.m					
22	**6 mm plastering with 1 :3 cement, medium sand mortar in ceilings**						
	Bedrooms	2	3.50	3.50	-	24.50m²	
	Living rooms	2	3.00	3.50	-	21.00m²	
	Study rooms	2	3.70	2.00	-	14.80m²	
	Kitchens	2	2.50	2.50	-	12.50m²	
	Baths	2	1.20	1.40	-	3.36m²	
	W.Cs	2	1.20	1.00	-	2.40m²	
	Front verandah	1	8.90	2.00	-	17.80m²	
	Back verandahs	2	4.15	2.50	-	20.75m²	
	Soffits of front verandah Lintels	1	8.10	0.20	-	1.62m²	L= 8.90 - 2 x 0 .40= 8.10 m
	Soffits of back verandah lintels	2	3.75	0.20	-	1.50m²	L = 4.15 - 0.40 = 3.75 m
	Staircase						
	Inclined slab	2	2.54	1.10	-	5.59m²	
	Landing slab middle	1	2.30	0.90	-	2.07m²	
	Landing slab (1st Floor level)	1	2.30	1.10	-	2.53m²	
	Soffit of lintel at entrance	1	2.30	0.30	-	0.69m²	
	Under sides of sunshades						
	Sunshades W	8	1.20	0.50	-	4.80m²	Total of sun shade = 18.22 sq.m*
	Sunshades W_1 kitchen side	2	1.10	0.50	-	1.10m²	
	Front verandah sunshade	1	9.20	0.60	-	5.52m²	Total excluding bed rooms and living rooms=103.83sqm
	Back verandah sunshade continous	1	13.60	0.50	-	6.80m²	
					Total	149.33m²	
23	**Skirting 20 cm high with12 mm thick 1:3 cement coarse sand mortar neat cement finished -**						
	Bedrooms	2	14.00	-	-	28.00m	Lengths inner perimeter
	Living rooms	2	13.00	-	-	26.00m	
	Jambs of main rooms doors D	10	0.30	-	-	3.00m	
	Staircase room	1	9.90	-	-	9.90m	
	Jambs at entrance	2	0.30	-	-	0.60m	
	Study rooms	2	11.40	-	-	22.80m	
	Front verandah long wall	1	8.90	-	-	8.90m	
	Front verandah side walls	2	2.20	-	-	4.40m	
	Back verandah long walls	2	4.15	-	-	8.30m	
	Back verandah side walls	4	2.70	-	-	100.80m	
	Pillars 3 faces	4	0.80	-	-	3.20m	
	Jambs study rooms door D	2	0.20	-	-	0.40m	Total of study room, verandah etc= 69.30 m
					Total	126.30m	
	Deduct door opening D	12	1.00	-	-	12.00m	
				Net Total		114.30 m	

24	**Dado 12 mm thick 1:3 cement coarse sand mortar neat cement finished (in kitchen, bath and W.C)**						
	Kitchen 50 cm high	2	10.00	-	0.50	10.00m²	Lengths inner perimeter
	W.C 50 cm high	2	4.40	-	0.50	4.40m²	
	Bathroom 1 m high	2	5.20	-	1.00	10.40m²	
	Jambs of kitchen door D_1	2	0.20	-	0.50	0.20m²	
	Jambs of W.C door D_2	2	0.20	-	0.50	0.20m²	
	Jambs of bath door D_2	2	0.20	-	1.00	0.40m²	
					Total	25.60m²	
	Deduct -						
	Kitchen door D_1	2	0.90	-	0.50	0.90m²	
	W.C door D_2	2	0.75	-	0.50	0.75m²	
	Bath door D_2	2	0.75	-	1.00	1.50m²	
				Total of deduction		3.15m²	
					Net Total	22.45m²	
25	**20 mm plastering with 1:3 cement coarse sand mortar neat cement finished in steps**						
	Front steps tread and riser	1	2.30	1.21	-	2.78m²	B = 2 x 0.30 + 3 x 0.17 + 0.10 =1.21 m
	Back steps, tread and riser	2	1.00	1.21	-	2.42m²	
	Sides of front and back steps	3 x 2	-	0.60	0.27	0.97m²	
		3 x 2	-	0.30	0.17	0.31m²	
	Stair case steps, tread and riser	2 x 8	1.10	0.425	-	7.48m²	B = 25 + 17.5 = 42.5 cm = 0.425 m
					Total	13.96 m²	
	VII. Flooring						
26	**2.5 cm C.C 1:2:4 floor over and including 7.5 cm lime concrete**						
	Bedrooms	2	3.50	3.50	-	24.50m²	
	Living rooms	2	3.00	3.50	-	21.00m²	
	Staircase room	1	2.30	3.50	-	8.05m²	
	Sill of entrance	1	2.30	0.30	-	0.69m²	
	Study rooms	2	3.70	2.00	-	14.80m²	
	Kitchens	2	2.50	2.50	-	12.50m²	
	Bathrooms	2	1.20	1.40	-	3.36m²	
	W.Cs	2	1.20	1.00	-	2.40m²	
	Front verandah	1	8.90	2.00	-	17.80m²	
	Back verandahs	2	4.15	2.50	-	20.75m²	
					Total	125.85m²	
27	**2.5 cm C.C. 1:2:4 floor (without lime concrete)**						
	Sills of door D	10	1.00	0.30	-	3.00m²	
	Sills of door D (study room)	2	1.00	0.20	-	0.40m²	
	Sills of door D_1	2	0.90	0.20	-	0.36m²	
	Sills of door D_2	4	0.75	0.20	-	0.60m²	

	Sills of verandah opening over plinth dwarf wall						
	Front verandah	1	8.10	0.20	-	1.62m^2	L=8.90-2x.40=8.10 m
	Back verandah	2	3.75	0.20	-	1.50m^2	L=4.15-.40=3.75 m
	Staircase landing	1	2.30	0.90	-	2.07m^2	Over R.C.C landing slab
					Total	9.55m^2	
	VIII Painting						
28	**Painting two coats over one coat of priming**						
	Panelled door D	12 x $2\,^{1}/_{4}$	1.00	-	2.10	56.70m^2	1 1/8 for one face
	Panelled door D_1	2 x $2\,^{1}/_{4}$	0.90	-	2.10	8.51m^2	1 1/8 for one face
	Panelled door D_2	4 x $2\,^{1}/_{4}$	0.75	-	2.10	14.18m^2	1 1/8 for one face
	Panelled Window W	12 x $2\,^{1}/_{4}$	0.90	-	1.20	29.16m^2	1 1/8 for one face
	Panelled Window W_1	4 x $2\,^{1}/_{4}$	0.80	-	1.00	7.20m^2	1 1/8 for one face
	Panelled Window W_2	2 x $2\,^{1}/_{4}$	0.75	-	1.00	3.38m^2	1 1/8 for one face
	Painting window bars W	12	0.75	-	1.05	9.45m^2	One clear flat area in between chaukhat
	Painting Window bars W_1	4	0.65	-	0.85	2.21m^2	
	Painting Window bars W_2	2	0.60	-	0.85	1.02m^2	
	Iron grill in staircase railing	1	5.38	-	0.80	4.30m^2	
					Total	136.11m^2	
29	**Coaltar painting two coats on back of chaukhats**						
	Door D	12	5.10	0.10	-	6.12m^2	Lengths same as for chaukhats in item 15
	Door D_1	2	4.60		0.10	-	0.92m^2
	Door D_2	4	4.45	0.10	-	1.78m^2	
	Window W	12	4.20	0.10	-	5.04m^2	
	Window W_1	4	3.60	0.10	-	1.44m^2	
	Window W_2	2	3.50	0.10	-	0.70m^2	
					Total	16.00 m^2	
	IX. White washing and colour washing						
30	White washing 3 coats - Walls (inside)			Same as for inside plasting in item (21)		410.48m^2	
	Ceiling, under side of sunshades etc.			Same as for ceiling plastering in item (22)		149.33m^2	
					Total	559.81m^2	

31	**Colour washing two coats over one coat of white washing (outside)**						
	walls (outside)	Same as for outside wall plastgering in item (21)				146.33m²	Portion below G.L to be deducted
	Upper surface of sunshades	Same as marked* in item (22)				18.22m²	Under surface same as lower surface.
					Total	164.55m²	Edges neglected
	Deduct 10 cm portion below G.L.	1	47.90	-	0.10	4.79	L - Outer perimeter - steps
				Net	Total	159.76 sq.m	= (2 x 17.10 + 2 x 9.00) - (2.30 + 2 x 1.00) = 47.90m
	X. Misc. Items						
32	10 mm dia. A.C rain water pipes (6 Nos)....	6	3.60	-	-	21.60 m	L = 3.00 + 0.12 + 0.50 = 3.62 = 3.60 m

First Floor

Details of Measurement and Calculation of quantities

Item No.	Particulars items and of works	No.	Length m	Breadth m	Height or depth m	Quantity	Explanatory notes
	II. Concrete						
1	**Lime concrete in roof terracing 7.5 cm thick complete with surface finishing**						
	Roof of 1st floor in between parapet	1	16.70	8.60	-	143.62m^2	Mumty room tobe deducted.
	Roof of stair case room (mumty room) including chujja projection	1	3.70	5.10	-	18.87m^2	L=2.30+2x.20+2x.50=3.70 m
					Total	162.49m^2	B= 3.70+2x.20+2x.50=5.10m
	Deduct mumty room at 1st floor level	1	2.70	4.10	-	11.07	
					Net Total	151.42m^2	
2	**R.C.C work 1:2:4 excluding steel reinforcement and its bending but including centering and shuttering and binding steel**						
	Roof slab	same as in item (5) of G.F			15.642		Slab of all rooms and verandahs
	Lintels						
	Over main room doors D	8	1.30	0.20	0.10	0.208m^3	Bearing 15 cm
	Over main room						
	Over main room window W	8	1.20	0.20	0.10	0.192m^3	
	Over main room shelves	4	1.30	0.20	0.10	0.104m^3	
	Over entrance of staircase	1	2.70	0.20	0.20	0.108m^3	
	Over doors D study room	2	1.30	0.20	0.10	0.052m^3	
	Over doors D_1 kitchen	2	1.20	0.20	0.10	0.048m^3	
	Over doors D_2 Bath and W.C	4	1.05	0.20	0.10	0.084m^3	
	Over window W study room	4	1.20	0.20	0.10	0.096m^3	
	Over window W_1 kitchen	2	1.10	0.20	0.10	0.044m^3	Side windows
	Over shelves kitchen	4	1.30	0.20	0.10	0.104m^3	
	Over R.C.C Jalli over door D_2 of bath and W.C	4	1.05	0.20	0.10	0.084m^3	
	Over front verandah	1	9.20	0.20	0.20	0.368m^3	20 cm thick
	Over back verandah including window W_1 W_2	1	13.60	0.20	0.15	0.408m^3	15 cm thick
	Sun shades, shelf slab	Same as in item (5) of G.F				1.175m^3	
	Stair case inclined slab and landings	Same as in item (5) of G.F				1.541m^3	
	Steps (without reinforcement)	8 x 21.10 $^1/_2$ (0.25x 0.175)				0.385m^3	
	Mumty room - Roof slab including chujja projections	1	3.70	5.10	0.10	1.887m^3	
	Lintel over door	1	1.20	0.20	0.10	0.024m^3	
	Lintel over windows	3	1.50	0.20	0.10	0.090m^3	Bearing 15 cm
					Total	22.644m^3	

Item No.	Particulars items and of works	No.	Length (m)	Breadth (m)	Height or depth (m)	Quantity	Explanatory notes
3	2.5 cm c.c 1 : 2 : 4 nosing in steps of stair case neat cement finished	9 x 2	1.10	-	-	19.80 m	
4	R.C.C 1:2: 4 newal post in stair case 10 cm x 10 cm 1 m high including reinforcement complete work	3	-	-	-	3 Nos	One at first floor one at middle and one at mumty floor
5	**R.C.C 1:2:4 handrail over grill including reinforcement complete work** - Stair Case inclined	1	5.38	-	-	5.38m	
	Upper landing	1	1.30	-	-	1.30m	
	Front verandah	1	8.10	-	-	8.10m	L=8.90-2x.40=8.10 m
	Back verandah	2	3.75	-	-	7.50m	L=4.15-.40=3.75 m
					Total	22.28 m	
6	**4 cm thick R.C.C Jalli including reinforcement complete work** - Over doors of Bath and W.Cs	4	0.75	-	0.50	1.50m²	
	Over windows of mumty room	3	1.20	-	0.50	1.80m²	
					Total	3.30m²	
7	**III Brick work First class brickwork in 1:6 cement local sand mortar in superstructure**						
	Main rooms-	1	17.10	0.20	3.00	10.26m³	L = 16.90 + 0.20 = 17.10 m
	Front long walls	2	7.40	0.20	3.00	8.88m³	L = 7.20 + 0.20 = 7.40 m
	Cross walls	6	3.70	0.20	3.00	13.32m³	L = 3.90 - 0.20 = 3.70 m
	Stair case room front wall	1	2.30	0.20	0.60	0.28m³	Above lintel
					Total	32.74m³	
	Deduct						
	Door opening D	10	1.00	0.20	2.10	4.20m³	
	Window opening W	8	0.90	0.20	1.20	1.73m³	
	Shelve opening	4	1.00	0.10	1.80	0.72m³	Back of shelf 10 cm
	Lintels over door	10	1.30	0.20	0.10	0.26m³	
	Lintels over window W	8	1.20	0.20	0.10	0.20m³	
	Lintels over shelves	4	1.30	0.20	0.10	0.10m³	
			Total of deduction			7.21m³	
			Net Total for main rooms			25.53 m³(i)	
	Study room, kitchen, Bath and W.Cs front and back verandahs	Same as for item (13) GF 22.414 (ii)					

Item No.	Particulars items and of works	No.	Length (m)	Breadth (m)	Height or depth (m)	Quantity	Explanatory notes
	Mumty room all 4 walls	1	12.80	0.20	2.50	6.40m^3	Total centre line length = 12.80 m
	Deduct door D1	1	0.90	0.20	2.10	0.378m^3	
	Deduct Window W2	3	1.20	0.20	0.90	0.65m^3	= 1.388 cu m
	Deduct Jalli above W3	3	1.20	0.20	0.50	0.36m^3	
			Total of	Mumty room		5.012m^3 (iii)	
	Parapet long wall	2	17.10	0.20	0.975	6.67m^3	
	Parapet short wall	2	8.60	0.20	0.975	3.35m^3	
				Total of para pet		10.02 m^3(iv)	
		Grand total of (i), (ii), (iii) and (iv)				62.976 m^3	
8	**10 cm thick first class brickwork in partition wall with 1:3 cement coarse sand motar with hoop iron of 6 mm dia. steel reinforcement every fourth layer**	2	1.20	-	3.00	7.20m^2	
9	**10 cm brick band at top of parapet**	1	52.20	-	-	52.20 m	L=2(17.10+9.00) = 52.20 m
	IV. Wood work-doors and windows						
10	**Sal wood work in chaukhats in doors and windows** - first floor doors and windows			Same as in item (15) of G.F		1.247m^3	
	Mumty room door D_1	1	5.20	0.10	0.075	0.039m^3	
	Mumty room window W_2	3	4.20	0.10	0.075	0.095m^3	
					Total	1.381m^3	
11	**3 cm thick panelled shutters of deodar wood in doors and windows-first floor doors &windows**	Same as in item (16) of G.F				43.459m^2	
	Mumty room door D_1	1	0.78	-	2.04	1.591m^2	
					Total	45.05m^2	
12	**3 cm thick fully glazed shutters of deodar wood**						
	Mumty room windows W	3	1.68	-	0.78	3.931m^2	
13	**Door and window fittings of oxidized iron**			Same as in items (11) and (12) above			
				= 45.05 + 3.931		= 48.981 m^2	

Item No.	Particulars items and of works	No.	Length m	Breadth m	Height or depth m	Quantity	Explanatory notes
	V Steel and iron work						
14	**Steel reinforcement**						
	bars including bending	22.349 x $\frac{1}{100}$	x 78.5	=	17.544q		@ 1% of R.C.C work in item (2) excluding stair case steps = 1/100 x (22.734 - 0.385) = 1/100 x 22.349 m^3
15	**Iron work in hold fasts and windows bars - doors and windows of first floor**		Same as in item (19) of G.F.			563.34 kg	
	Mumty room -						
	Hold fast in door D_1	6	@1 kg	each	-	6 kg	
	Hold fast in windows W_2	3 x 4	@ 1 kg	each	-	12 kg	
	20 mm dia window bars in windows W_2 of mumty room @ 2.47 kg per m	3 x 9	x 0.90	x 2.47	=	60.02 kg	6 bars 0.90 m each
					Total	641.36 kg	
						= 6.414 q	
16	**Iron grill work in railings -**						
	Staircase railing two flights	1	5.38	-	0.80	4.31m^2	
	Upper landing	1	1.20	-	0.80	0.96m^2	
	Front verandah railing	1	8.10	-	0.80	6.48m^2	L = 8.90 - 2 x.40 = 8.10 m
	Back verandah railing	2	3.75	-	0.80	6.00m^2	L=4.15 - .40= 3.75 m
					Total	17.75m^2	
	VI. Plastering and Pointing						
17	**12 mm plastering with 1:6 cement local sand mortar in walls**						
	Inside plastering Main rooms						Excluding skirting and Dado at bottom
	Bed rooms	2	14.80	-	2.80	82.88m^2	L= Inner perimeter =14.80
	Living rooms	2	13.60	-	2.80	76.16m^2	L= Inner perimeter = 13.60
	Staircase room	1	12.00	-	3.00	36.00m^2	L=Inner perimeter = 12.00
	Face of wall below stair case entrance lintel 20 cm wide	2	0.20	-	2.00	0.80m^2	
	Shelves - Jambs, sills and soflits	4	5.60	0.10	-	2.24m^2	
	Study room, kitchens, Bath and W.Cs., Verandahs, etc (of 30 cm wall)		Same as for item (21) in G.F			268.80m^2	
	Mumty room	1	12.00		2.50	30.00m^2	
					Total	496.88m^2	

Item No.	Particulars items and of works	No.	Length m	Breadth m	Height or depth m	Quantity	Explanatory notes
	Deduct door and window openings	Same as for item (21) in G.F				48.80m^2	
		Net total of inside plastering				448.08m^2	
	Outside plastering Outside of first floor	1	52.20	-	3.00	156.00m^2	L=Outer perimeter= 2(17.10+9.00) = 52.20 m
	Deduct						
	Window opening W	8	0.90	-	1.20	8.64m^2	One face
	Window opening W_1	4	0.80	-	1.00	3.20m^2	
	Window openings W_2	2	0.75	-	1.00	1.50m^2	
	Front verandah openings	1	8.10	-	2.20	17.82m^2	L=8.90-2x.40 = 8.10m
	Back verandah openigns	2	3.75	-	2.20	16.50m^2	L=4.15-.40=3.75 m
			Total of deduction			47.66m^2	
			Net Total of outside plastering 1st floor			108.94 (i) sq.m	
	Parapet wall (outer top and inner)	1	51.20	-	2.00	102.40m^2	(ii) L=Total length of 4 walls = 51.20 m Ht. = 2 x .90 + .20=2.00 m
	Mumty room - Outer side of walls	1	13.60	-	2.50	34.00m^2	L=Outer perimeter =13.60m
	Deduct door openings D_1	1	0.90	-	2.10	1.89m^2	
	Deduct window openings W_3	3	1.20	-	0.90	3.24m^2	
	Deduct R.C.C Jalli	3	1.20	-	0.50	1.80m^2	
			Net total of mumty			27.07m^2 (iii)	
		Total of outside plastering (i), (ii) and (iii) =				238.41m^2	
		Grand total of inside and outside plastering				686.49m^2	
18	**6 mm plastering with 1 :3 cement medium sand mortar in ceiling**						
	Bed rooms	2	3.70	3.70	-	27.38m^2	
	Living rooms	2	3.10	3.70	-	22.94m^2	
	First floor study room, Kitchen, bath and W.C verandahs, staircase, Sunshades, etc	Same as in item (22) of G.F.				103.83m^2	
	Mumty room - Ceiling	1	2.30	3.70	-	8.51m^2	
	Chujjas long	2	5.10	0.50	-	5.10m^2	L = 3.7 + .4 + 2 x 0.5 = 5.10m
	Chujjas short	2	2.70	0.50	-	2.70m^2	L = 2.30 + 0.40 = 2.70 m
					Total	170.46m^2	

Item No.	Particulars items and of works	No.	Length m	Breadth m	Height or depth m	Quantity	Explanatory notes
19	**Skirting 20 cm high with 12 mm thick 1:3 cement coarse sand mortar neat cement finished -**						
	Bedrooms	2	14.80	-	-	29.60m	L=Inner perimeter
	Livingrooms	2	13.60	-	-	27.20m	
	Jambs of main room doors D	10	0.20	-	-	2.00m	
	Study rooms, verandahs, etc	Same as in item (23) of G.F.				69.30m	
					Total	128.10m	
	Deduct door openings D	12	1.00	-	-	12.00m	
					Net total	116.10m	
20	**Dado 12 mm thick 1:3 cement coarse sand mortar neat cement finished (in kitchen, bath and W.C)**	Same as in item (24) of G.F.				$22.45m^2$	
	VII. Flooring						
21	**2.5 cm C.C. 1:2:4 floor**						
	Bed rooms	2	3.70	3.70	-	$27.38m^2$	
	Living rooms	2	3.10	3.70	-	$22.94m^2$	
	Study rooms	2	3.70	2.00	-	$14.80m^2$	
	Ktichens	2	2.50	2.50	-	$12.50m^2$	
	Bath rooms	2	1.20	1.40	-	$3.36m^2$	
	W.Cs	2	1.20	1.00	-	$2.40m^2$	
	Front verandah	1	8.90	2.20	-	$19.58m^2$	Including sills openigns
	Back verandahs	2	4.15	2.70	-	$22.41m^2$	Including sills openings
	Staircase landing (first floor levels)	1	2.60	0.40	-	$1.04m^2$	
	Staircase landing (middle)	1	2.60	1.00	-	$2.60m^2$	
	Staircase landing (2nd floor levels)	1	2.60	0.40	-	$1.04m^2$	
	Sills of doors D	12	1.00	0.20	-	$2.40m^2$	
	Sills of doors D_1	2	0.90	0.20	-	$0.36m^2$	
	Sills of doors D_2	4	0.75	0.20	-	$0.60m^2$	
					Total	$133.41m^2$	
	VIII. Painting						
22	**Painting two coats over one coat of priming - First floor doors, windows, window bars, staircase railing grills**	Same as in item (28) of G.F.				$136.11m^2$	
	Front verandah grill	1	8.10	-	0.80	$6.48m^2$	One face for both sides
	Back verandah grill	2	3.75	-	0.80	$6.00m^2$	
	Staircase upper landing grill	1	1.20	-	0.80	$0.96m^2$	
	Mumty room panelled door	1 x $2^1/_4$	0.90	-	2.10	$4.25m^2$	
	Glazed windows	3x1	1.20	-	0.90	$3.24m^2$	
	Window bars	3x1	1.05	-	0.75	$2.36m^2$	
				Total		$159.40m^2$	

Item No.	Particulars items and of works	No.	Length m	Breadth m	Height or depth m	Quantity	Explanatory notes
23	**Coaltar painting two coats on back of chaukhats - First floor**						
	doors and windows	Same as in item 29 of G.F.				$16.00m^2$	
	Mumty room - Door D_1	1	4.60	0.10	-	$0.46m^2$	
	Windows W_2	3	4.20	0.10	-	$1.26m^2$	
					Total	$17.72m^2$	
24	**IX. White washing and Colour washing -**						
	White washing 3 coats - Walls (inside)	Same as inside plastering in item (17) F.F				$448.08m^2$	
	Ceiling underside of sunshades	Same as plastering in item (18) F.F.				$170.46m^2$	
					Total	$618.54\ m^2$	
25	**Colour washing two coats over one coat of white washing walls (out side)**	Same as out side plastering in item (17) F.F.				$238.41\ m^2$	
	X Misc. Items						
26	**100mm dia. A.C. rain water pipe**	6	3.20	--		19.20m	Including bend

Abstract of estimated cost (Ground floor)

Item No.	Particulars of items of work	Quantity	Unit	Rate Rs.Ps.	Per	Amount Rs.Ps.
	I Earthwork			Rate can be quoted from the prevailing schedule of rates		Amount can be calculated by multiplying the quantity with its rate
1	Site clearance and setting out	1	Job		L.S.	
2	Earthwork in excavation in foundation	55.75	cu m		% cu m	
3	Earthwork in filling in plinth	46.52	cu m		% cu m	
	II concrete					
4	Lime concrete in foundation	19.36	cu m		/ cu m	
5	R.C.C. work 1:2:4 excluding steel reinforcement bars and its bending but including centering and shuttering and binding steel	21.058	cu m		/ cu m	
6	2.5cm 1:2:4 nosing in steps neat cement finished	32.70	m		/m	
7	R.C.C 1:2:4 Newal post 10cm x 10cm, 1 m height including reinforcement complete work	2	No.		each	
8	R.C.C. 1:2:4 hand rail in staircase including reinforcement complete work.	5.48	m		/m	
9	4cm thick R.C.C. Jalli including reinforcement complete work	1.50	Sq m		/ sq m	
10	2.5 cm Damp proof course C.C 1:1½:3 with water proofing compound	28.97	Sq m		/ sq m	
	III Brick work					
11	First class brick work in lime mortar in foundation and plinth	41.94	cu m		/ cu m	
12	First class brickwork in lime mortar in superstructure in 30cm wall	36.15	cu m		/ cu m	
13	First class brickwork in 1:6 cement local sand mortar in superstructure in foundation and plinth	22.414	cu m		/ cu m	
14	10 cm thick first class brickwork in partition wall in 1:3 cement coarse sand mortar with hoop iron or 6mm dia. steel reinforcement every fourth layer	7.20	sq m		/ sq m	
	IV Wood work Doors and Windows					
15	Salwood work in chowkhats in doors and windows	1.247	cu m		/ cu m	
16	4 cm thick panelled shutters of deodar wood in doors and windows	43.459	sq m		/sq m	
17	Door and window fittings of oxidized iron	41.197	sq m		/ sq m	

Item No.	Particulars of items of work	Quantity	Unit	Rate Rs. Ps.	Per	Amount Rs. Ps.
	V. Steel and Iron work			Rate can be quoted from the prevailing schedule of rates		Amount can be calculated by multiplying the quantity with its rate
18	Steel reinforcement bars including bending	16.226	quintal		/q	
19	Iron work in hold fasts and window bars	5.633	quintal		/q	
20	Iron grill work in stair case railing	4.304	sq m		/sq m	
	VI. Plastering and pointing					
21	12mm plastering with 1:6 cement, local sand mortar in walls	562.81	sq m		/ sq m	
22	6mm plastering with 1:3 cement, medium sand mortar in ceiling	149.33	sq m		/ sq m	
23	Skirting 20cm high with 12mm thick 1:3 cement, coarse sand mortar neat cement finished	114.30	m		/m	
24	Dado 12mm thick 1:3 cement, coarse sand mortar neat cement finished	22.45	sq m		/ sq m	
25	20mm plastering with 1:3 cement, coarse sand mortar neat cement finished in steps	13.96	sq m		/sq m	
	VII flooring					
26	2.5cm C.C. 1:2:4 floor over and including 7.5cm lime concrete	125.85	sq m		/sq m	
27	2.5 cm C.C. 1:2:4 floor	9.55	sq m		/sq m	
	VIII painting					
28	Painting two coats over one coat of priming	130.16	sq m		/sq m	
29	Coal tar painting two coats on back of chowkhats	16.00	sq m		/sq m	
	IX White washing and colour washing					
30	White washing 3 coats inside	565.81	sq m		/sq m	
31	Colour washing 2 coats over one coat of white washing	159.76	sq m		/sq m	
32	100 mm dia. A.C. rain water pipe	21.60	m		/m	

Total

Add 8% for water supply and sanitary works
Add 8% for electrification works

Total

Add 3% for contingencies
Add 2% for work charged establishment

Grand Total

Abstract of Estimated Cost (First floor)

Item No.	Particulars of items of work	Quantity	Unit	Rate Rs.Ps.	Per	Amount Rs.Ps.
	II. Concrete			Rates can be quoted from the prevailing schedule of rates		Amount can be calculated by multiplying the quantity with its rate
1	Lime concrete in roof terracing 7.5 cm thick complete with surface finishing	151.42	sq m		/sq m	
2	R.C.C work 1:2:4 excluding steel reinforcement and its bending but including centering and shuttering and binding steel	22.644	cu m		/cu m	
3	2.5cm C.C. 1:2:4 nosing in steps of stair case neat cement finished	19.80	m		/m	
4	R.C.C 1:2:4 newal post in stair case 10cm x 10cm, 1m height including reinforcement complete work	3	nos		/nos	
5	R.C.C 1:2:4 hand rail over grill including reinforcement complete work	22.28	m		/m	
6	4cm thick R.C.C jalli including steel reinforcement complete work	3.30	sq.m		sq m	
	III Brick work					
7	First class brickwork in 1:6 cement, local sand mortar in superstructure in 20cm thick wall	63.56	cu m		/cu m	
8	10cm thick first class brickwork in partition wall with 1:3 cement, coarse sand mortar with hoop iron or 6mm dia. steel reinforcement every fourth layer	7.20	sq m		/sq m	
9	10 cm thick brick band with 1:6 cement, local sand mortar at top of parapet	52.20	m		/m	
	IV Wood work - Doors and Windows					
10	Salwood work in chow khats in doors and windows	1.331	cu m		/cu m	
11	3 cm thick panelled shutters of deodar wood in doors and windows	42.554	sq m		/sq m	
12	3cm thick fully glazed shutters of deodar wood	3.931	sq m		/sq m	
13	Door and window fittings of oxidized iron	46.485	sq m		/sq m	
	V Steel and iron work					
14	Steel reinforcement bars including bending	17.544	quintal		/q	
15	Iron work in hold fasts and window bars	6.414	quintal		/q	
16	Iron gril in railings	17.75	sq m		/sq m	

Item No.	Particulars of items of work	Quantity	Unit	Rate Rs. Ps.	Per	Amount Rs. Ps.
	VI. Plastering and pointing					
17	12mm plastering with 1:6 cement, local sand mortar in walls	692.76	sq m		/sq m	
18	6mm plastering with 1:3 cement, medium sand mortar in ceiling	170.46	sq m		/sq m	
19	Skirting 20cm high with 12mm thick 1:3 cement, coarse sand mortar neat cement finished	116.10	m		/m	
20	Dado 12mm thick 1:3 cement, coarse sand mortar neat cement finished	22.45	sq m		/sq m	
	VII flooring					
21	2.5cm C.C. floor	133.41	sq m		/sq m	
	VIII painting					
22	Painting two coats over one coat of priming	152.85	sq m		/sq m	
23	Coaltar painting two coats on back of chowkhats	17.72	sq m		/sq m	
	IX White washing and color washing					
24	White washing 3 coats inside	624.54	sq m		/sq m	
25	Colour washing two coats over one coat of white washing	238.68	sq m		/sq m	
	X Miscellaneous items					
26	100mm dia. A.C. rain water pipe	19.20	m		/ m	

Total

Add 8% for water supply and sanitary works
Add 8% for electrification works

Total

Add 3% for contingencies
Add 2% for workcharged establishment

Grand Total

(Refer Ex.No.2.12.116, Figs 1 & 2)

PROCEDURE

TASK 1: **Prepare rate analysis of plain cement concrete (10m³)**

DATA (Specification)

- PCC : 1:5:10
- Coarse aggregate : 40mm
- Unit : $1m^3$
- Take : $1m^3$

Particular	Qty or Nos	Rate	Cost
		Rs. Ps.	Rs. Ps.
Materials			
Broken stone 40mm gauge	9.50 cu m	650.00 per cu m	6175.00
Sand (local)	4.75 cu m	700.00 per cu m	3325.00
Cement ($28^{1/2}$ bags)	0.95 cu m	7650.00 per cu m	7267.50
		Total	16767.50
Labour			
Mistri (Head mason)	$^1/_2$ no	350.00 per day	175.00
Mason	1 $^1/_2$ no	300.00 per day	450. 00
Mazdoor (Beldar)	12 nos	220.00 per day	2640.00
Boy or woman coolie	18 nos	200.00 per day	3600.00
Bhishti (Including curing)	4 nos	200.00 per day	800.00
Sundries T and P etc	Lump sum	120.00 L.S	120.00
		Total	7785.00
		Total of materials and labour	24552.50

Particular	Qty or Nos	Rate	Cost
		Rs. Ps.	Rs. Ps.
Add 1 $^1/_2$% water charges	---	---	368.00
Add 10% contractor's profit	---	---	2455.25
		Grand total	**27375.75**
Rate per cu m- Rs. 27375.75/10	**= Rs.2737.57**		**for 10 cu m**

TASK 2 : **Prepare the rate analysis of RCC work 1:2:4 for beams, slabs, etc.**

Particulars	Qty or Nos	Rate Rs. Ps.	Cost Rs. Ps.
Materials			
Stone ballast 20mm gauge	8.80 cu m	1800.00 per cu m	15840.00
Sand (coarse)	4.40 cu m	1500.00 per cu m	6600.00
Cement (66 pags)	2.20 cu m	7650.00 per cu m	16830.00
Steel, mild steel bars @ 1%=			
0.1 cu m @ 78.5 q/cu m=7.85q	7.85 q	4400.00 per q	34540.00
Binding wire	1.50 kg	65.00 per q	97.50
		Total	73907.50
Labour			
Mistri (Head Mason)	1/2 no	350.00 per day	175.00
Mason	3 nos	300.00 per day	900.00
Mazdoor (Beldar)	12 nos	220.00 per day	2640.00
Boy or woman coolie	20 nos	200.00 per day	4000.00
Bhishti (including curing)	6 nos	200.00 per day	1200.00
Sundries T. and P etc	Lump sum	140.00 L.S	140.00
		Total	9055.00

Particular	Qty or Nos	Rate	Cost
		Rs. Ps.	Rs. Ps.
Bending cranking and binding steel bars in position blacksmith (II class)	8 nos	280.00 per day	2240.00
Mazdoor (Belder)	8 nos	220.00 per day	1760.00
T. and P	Lump sum	90.00 L.S	90.00
		Total	4090.00
Centering and shuttering (both erection and dismantling)			
Timber planks and balies	Lump sum	1500.00 L.S	1500.00
Carpenter (II class)	10 nos	280.00 per day	2800.00
Mazdoor (Belder)	10 nos	220.00 per day	2200.00
Nails	Lump sum	200.00 L.S	200.00
T. and P.	Lump sum	70.00 L.S	70.00
		Total	6770.00
Total of materials and labour	---	---	93822.50
Add 1 $^1/_2$ % water charges	---	---	1407.33
Add 10% contractor's profit	---	---	9382.00
		Grand total	104611.83
Rate per cu m - Rs. 10461/10	= Rs10.461		for 10 cu m

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TASK 3: **Prepare the rate analysis of stone masonary work 1:2:4**

DATA (Specification of the work)

- Stone ballast : 20mm
- Sand (Coarse)
- Ratio : 1:2:4
- Unit : $1m^3$
- Take : $10m^3$

Particular	Qty or Nos	Rate	Cost
		Rs. Ps.	Rs. Ps.
Materials			
Stone including through bond			
Stone and wastage	12.5 cu m	1200.00 per cu m	15000.00
Cement (21 bags)	0.7 cu m	7650.00 per cu m	5355.00
Sand or bajri (local)	4.2 cu m	700.00 per cu m	2940.00
		Total	23295.00

Labour, etc			
Mistri (Head mason)	1/2 no	350.00 per day	175.00
Mason	12 nos	300.00 per day	3600.00
Mazdoor (Beldar)	10 nos	220.00 per day	2200.00
Coolie (boy or woman)	10 nos	200.00 per day	2000.00
Bhishti	1 1/2 nos	200.00 per day	300.00
Scaffolding	Lump sum	325.00 L.S	325.00
Sundries T and P etc	Lump sum	90.00 L.S	90.00
		Total	8690.00
	Total of materials and labour		31985.00
Add 1 $^{1}/_{2}$ % water charge			480.00
Add 10% contractor's profit			3198.50
Grand total			35663.50
Rate per cu m -Rs. 35664 / 10 = 3566.35			for 10 cu m

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TASK 4: **Prepare the rate analysis of brick masonry work**

- Take : $10m^3$

Particualar	**Qty or Nos**	**Rate**	**Cost**
		Rs. Ps.	**Rs. Ps.**
Materials			
Brick I-class (500 bricks per cu m)	5000 nos	450.00 per 100 nos	22500.00
Cement (13.5 bags)	0.45 cu m	7650.00 per cu m	3442.00
Sand (local)	2.7 cu m	700.00 per cu m	1890.00
		Total	27832.00
Labour			
Mistri (Head mason)	1/2 no	350.00 per day	175.00
Mason	10 nos	300.00 per day	3000.00
Mazdoor (Beldar)	7 nos	220.00 per day	1540.00
Boy or woman coolie	10 nos	200.00 per day	2000.00
Bhishti	2 nos	200.00 per day	400.00
Scaffolding	Lump sum	280.00 per day	280.00
Sundries T and P etc	Lump sum	90.00 per day	90.00
		Total	**7485.00**

Total of materials and labour	35317.00
Add $1^1/_2$ % water charges	530.00
Add 10% contractor's profit	3531.50
Grand total	39378.50 for 10m^3
Rate per cu m -Rs.39378 /10 = Rs.3938.00	

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TASK 5: **Prepare the rate analysis of wood work**

DATA (specification of the work)

Wood work for frame of doors and windows

- Frame size : 8x12mm
- Door size : 200x120 (salwood)

amount of 100/- may be added

1 For fixing the frame in position a lumpsum

- Cement mortar: 1:6
- Unit : 1M^2

2 For soft wood the labour may be reduced to 25%

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TASK 6 : **Prepare the rate analysis of plastering**

DATA

- Thickness of plastering : 12mm
- Cement mortar : 1:6
- Unit : 1m^2
- Take : 100m^2

Preliminary estimate

DATA

- Plinth area rate : Rs.25,000/m^2
- Cubical extend rate : Rs.7500/m^3

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TASK 7: **Prepare preliminary estimate of building**

1 Plinth area estimate

Plinth area of building	=	100m^2
Plinth area rate	=	Rs.25000/m^2
Approximate cost of building	=	25000x100
	=	Rs.25,00,000/-

For storeyed building, the plinth area estimate is prepared for each storey separately.

2 Cube rate estimate

Cubical content of building	=	350m^3
(100x3.5 (height)		
Cube rate of building	=	Rs.7500/m^3
Cube rate of building	=	350x7500
	=	Rs.2,625,000/-

Per unit basis: Per student for schools and hostels, per classrooms for schools, per bed for hospitals, per seat for cinema theatre halls, per day for factories, barracks and dormetories.

- Approximate estimate of a hostel building for 100 students @ Rs.20,000/-per students work out as Rs. 20 lakhs.
- Approximate cost of a 100 bed hospital @ 1,00,000 per bed comes to Rs. 1 crore
- Approximate cost of a barrack for 10 days @ 20,000 per days comes to Rs. 2 lakhs.

1 Irrigation channels

i Per kilometer basis depending on the capacity of channel.

ii Area of land commanded ie., per hectare basis

- The approximate cost of 10km length of irrigation channel of 3m^3/sec, capacity @ Rs. 70,000/per km works out Rs.7 lakhs.
- For an irrigation project having a commanded area 2000 hectares, approximate cost Rs.1000/hectare comes to Rs. 20 lakhs.

2 Roads and highways

Per kilometer basis depending on the nature of road, the width and thickness of mettaling, etc.

For 10km of a state highway approximate cost Rs. 5 lakhs/km work out 50 lakhs.

Estimation of earth work

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TASK 8: **Quantities of earth work by trapezoidal and prismoidal formula**

A railway embankment is 12m wide. The ground is level in direction transverse to the centre line. Calculate the volume contained in a 100m length by trapezoidal rule and prismoidal rule, if the direction side slope is 1.5:1. The centre heights at 20m interval are 3.7m, 2.6m, 3.4m, 2.8m, 3.0m, 2.2m.

Solution

For a level section A = (b + sh) h

Slope = 1.5:1, hence s = 1.5

b = 12m

Let the area at different sections be A1, A2,-----

A_1 = (12 + 1.5 x 3.7) 3.7 = 64.935m^2

A_2 = (12 + 1.5 x 2.6) 2.6 = 41.34m^2

A_3 = (12 + 1.5 x 3.4) 3.4 = 58.14m^2

A_4 = (12 + 1.5 x 2.8) 2.8 = 45.36m^2

A_5 = (12 + 1.5 x 3.0) 3.0 = 49.50m^2

A_6 = (12 + 1.5 x 2.2) 2.2 = 33.66m^2

Trapezoidal rule

$$V = L\left[\left(\frac{A_1 + A_6}{2}\right) + A_2 + A_3 + A_4 + A_5\right]$$

Distance (m)	0	50	100	150	200
RL (m)	164.5	165.2	166.8	167	167.2

$$= 20\left[\left(\frac{64.935 + 33.66)}{2} - 41.34 + 58.14 + 45.36 + 49.50\right)\right]$$

= 4872.7m^2

Prismoidal rule

Distance	0	50	100	150	200
RL (m)	164.5	165.2	166.8	167	167.2
Formation level (m)		166	166.5		167 167.5 168
Depth of filling h (m)	1.5	1.3	0.2	0.5	0.8

$$V = \frac{L}{3}\left[(A_1 + A_6) + 4(A_2 + A_4) + 2(A_3 + A_5)\right]$$

$$\frac{20}{3}\left[\left(\frac{64.93 + 33.66}{2}\right) + 4(41.34 + 45.36) + 2(58.14 + 49.50)\right]$$

$$\frac{20}{3}\left[(98.59) + 4(86.70) + 2(107.64)\right]$$

= 4404.46m^2

A road embankment is 8m wide and 200 m in length, at the formation level with a side slope of 1.5. The embankment has a rising gradient of 1 in 100m the ground levels at every 50m along the centre line area as follows:

The foundation level of zero chain age is 166m. Calculate the volume of earthwork.

Solution: rising gradient is 1 in 100m

Formation level increases by 0.5m from every 50m distance.

We know that the area of a cross-section is given by

A = (b+sh) h

Hence,

A_1 = (8 + 1.5 x 1.5) 1.5 = 15.375m^2

A_2 = (8 + 1.5 x 1.3) 1.3 = 12.935m^2

A_3 = (8 + 1.5 x 0.2) 0.2 = 1.66m^2

A_4 = (8 + 1.5 x 0.5) 0.5 = 4.375m^2

A_5= (8 + 1.5 x 0.8) 0.8 = 7.360m^2

Interval L = 50m

Trapezoidal rule

$$V = L \times \left[\left(\frac{A1 + A5}{2} \right) + A2 + A3 + A4 \right]$$

$$= 50\left[\left(\frac{15.375 + 7.360}{2} \right) + 12.935 + 1.66 + 4.375 \right]$$

= 1516.875m^3

Prismoidal rule

$$V = \frac{L}{3}\left[(A_1 + A_5) + 4(A_2 + A_4) + 2A_3 \right]$$

$$= \frac{50}{3}\left[(15.375 + 7.36) + 4(12.935 + 4.375) + (2 \times 1.66) \right]$$

$$V = \frac{L}{3}\left[(A_1 + A_5) + 4(A_2 + A_4) + 2(A_3) \right]$$

$$= \frac{50}{3}\left[(15.375 + 7.36) + 4(12.935 + 4.375) + (2 \times 1.66) \right]$$

= 1588.25m^3

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