SURVEYOR

NSQF LEVEL - 5

2nd Year (Volume I of II)

TRADE PRACTICAL

SECTOR : Construction

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 Year**

Trade : **Surveyor - 2nd Year (Volume I of II) Trade - Practical NSQF (Level - 5)**

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, by 2020 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 Mentor Councils comprising various stakeholder's viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, an autonomous body under Ministry of Skill Development & Entrepreneurship is entrusted with developing producing and disseminating Instructional Media Packages (IMPs) required for ITIs and other related institutions.

The institute has now come up with instructional material to suit the revised curriculum for **Surveyor - 2nd Year (Volume - I of II) Trade Practical NSQF Level - 5 in Construction Sector** under annual pattern. The NSQF Level - 5 Trade Theory 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 - 5 trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 5 the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these 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/ Addl.Secretary
Ministry of Skill Development & Entrepreneurship,
Government of India.

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 Directorate General of Training, 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 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.

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.

R. P. DHINGRA
EXECUTIVE DIRECTOR

Chennai - 600 032

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 2nd Year (Volume - I of II)** 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 intented to be used in practical workshop. It consists of a series of practical exercises to be completed by the trainees during the course of the Surveyor 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 - 5 syllabus are covered.

This manual is divided into Five modules. The Five modules are given below.

Module 1 - Contour survey

Module 2 - Curves

Module 3 - Total station

Module 4 - Cadastral survey

Module 5 - Road project in survey

Project work

The skill training in the shop floor is planned through a series of practical exercises centred 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 2nd year (Volume I of II) Trade Theory NSQF LEVEL - 5 in Construction. The contents are sequenced according to the practical exercise contained in NSQF LEVEL -5 syllabus on Trade Theory 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 the 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	**Make topography map using level instrument with contours.**	**3.1.67 to 74**
2	**Concept and set out of curves.**	**3.2.75 to 81**
3	**Perform survey work using modern survey instruments (total station) for prepare a map.**	**3.3.82 to 85**
4	**Concept of cadastral survey and make a site plan.**	**3.4.86 to 87**
5	**Perform a road project survey.**	**3.5.88 to 95**
6	**Perform survey work for prepare a topographical map, cadastral map, road project (Survey camp in a suitable hilly/undulated area).**	**3.5.88 to 95**
7	**Perform Auto CAD drawing field survey data.**	**3.5.88 to 95**

SYLLABUS

Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 112 Hrs.; Professional Knowledge 32 Hrs.	Make topography map using level instrument with contours.	67. Prepare contour (direct/indirect method) (20hrs.) 68. Interpolation of contour.(15 hrs.) 69. Draw contour lines. (12hrs.) 70. Locating contourgradients. (10hrs.) 71. Preparation of section from contour map. (15hrs.) 72. Computation of volume(prismoidal / trapezoidal)formula. (10hrs.) 73. Establishment of gradientby abney level. (10hrs.) 74. Make a topography mapwith 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. (32 hrs.)
Professional Skill 112 Hrs. Professional Knowledge 32 Hrs.	Concept & set out of curves	75. Computation of elementsof simple curve. (20 hrs.) 76. Set out of simple curve bylinear method. (15 hrs.) 77. Set out of simple curve byinstrument method. (17hrs.) 78. Set out of compoundcurve by instrument method. (15hrs.) 79. Set out of reverse curve by instrument method. (15hrs.) 80. Set out of transition curveby instrument method.(15hrs.) 81. 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	82. Temporary adjustment of Total station. (20hrs.) 83. Measurement of angle & coordinates and heights. (27hrs.) 84. Traversing using Total station. (40hrs.) 85. 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 28Hrs. Professional Knowledge 08 Hrs.	Concept of cadastral survey & make a site plan	86. Prepare a site plan by the help of mouza map. (16 hrs.) 87. 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 84Hrs. Professional Knowledge 24Hrs.	Performing a road project survey.	88. Road project reconnaissance. (10 hrs) 89. Preliminary survey. (18 hrs) 90. Final location survey including preparation of route map. (36 hrs) 91. Profile or longitudinal & cross sectional levelling & plotting. (20 hrs)	Types of surveys for location of a road. Points to be considered during reconnaissance survey. Classification of roads and terms used in road engineering, alignment of roads relative importance of length of road, height of embankment depth of cutting & filling, road gradients super elevation etc. (24 hrs.)

Professional Skill 84 Hrs. Professional Knowledge 24 Hrs.	Perform survey work for prepare a topographical map , c a d a s t r a l map(mouza map), road project (survey camp in a suitable hilly / undulated area)	92. Prepare topographical map (direct & indirect method). (28 hrs) 93. Make a cadastral/ mouza map & calculate the plot area. (28 hrs) 94. Prepare a detail road project more than 1KM. (28 hrs)	Details knowledge for preparation of topographical map. Details knowledge for preparation of cadastral map. Details knowledge for preparation of a road project. (24 hrs.)
Professional Skill 28Hrs. Professional Knowledge 08Hrs.	Perform AutoCAD drawing from field survey data.	95. Survey drawing practice using AutoCAD commands (28 hrs)	Use auto cad command survey software for survey drawing.(08hrs.)

Prepare contouring by radial line using plane table

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.

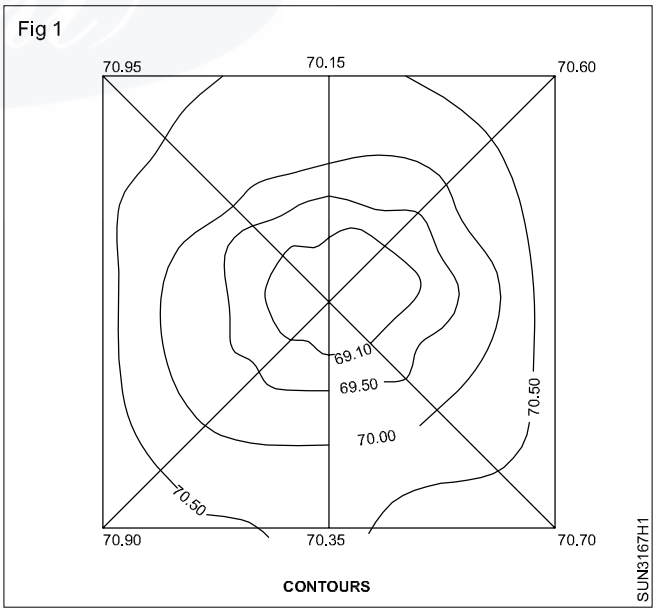
14 Mark the point with a peg and measure the distance of the point from the centre.

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



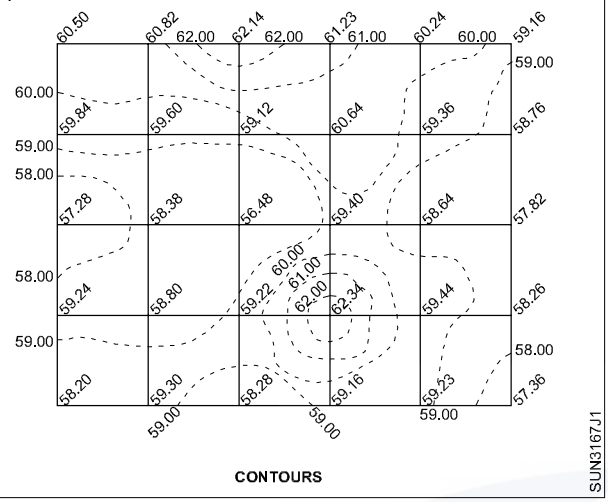
Indirect contouring by square method

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.**

PROCEDURE

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 bench mark 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 some reduced levels 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.**

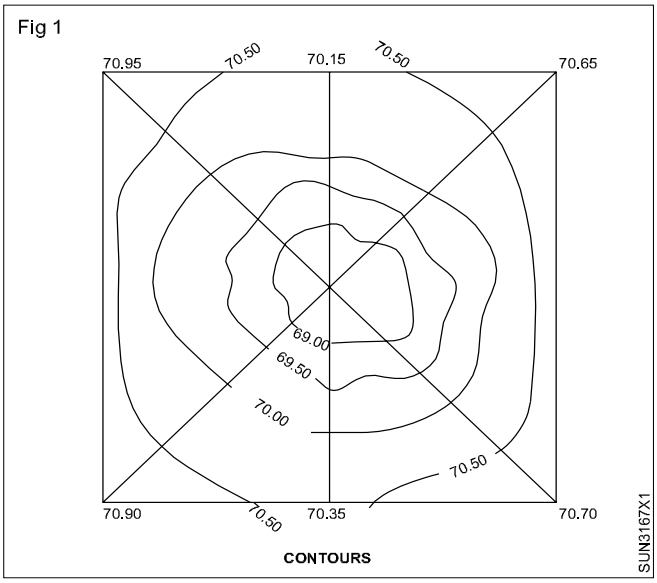
PROCEDURE

1 Follow the steps 1 to 10 of exercise no 3.1.67.

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



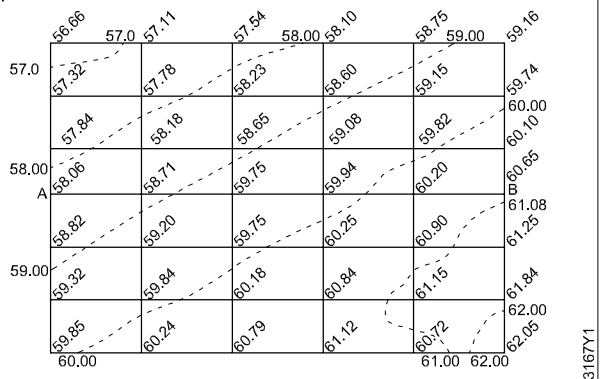
Indirect contouring by cross section

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.**

PROCEDURE

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

Fig 1



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 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 way lines to get the 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

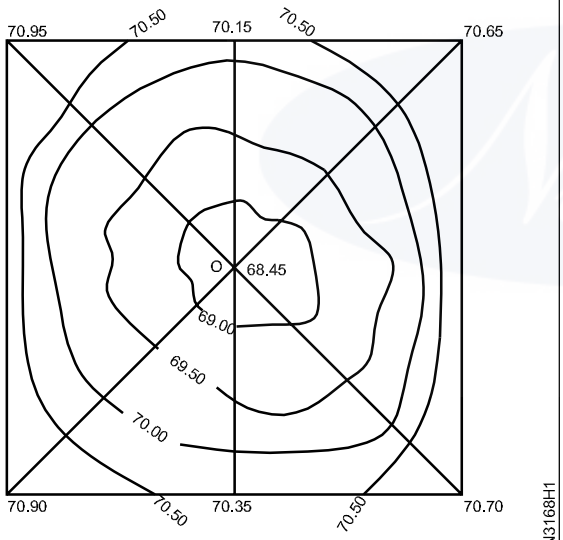
Materials

- 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 and 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.

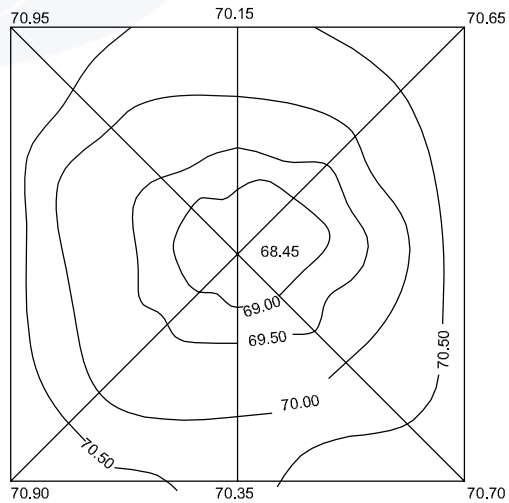
14 Similarly mark various contour points on each radial line.

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

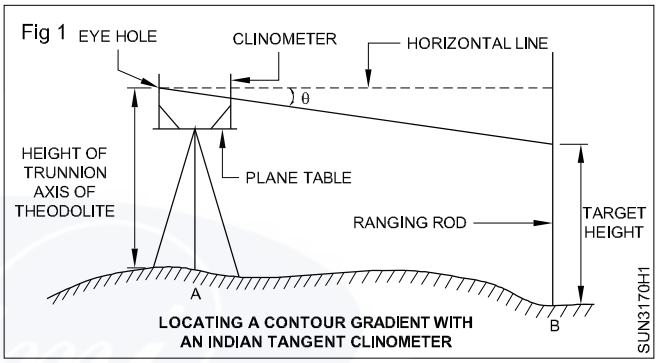
Materials

- Levelling field book.

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

- Set up the plane table at the point ‘A’.
- Place the clinometer on a plane table, which is centred over the point ‘A’.
- Level the clinometer and the line of sight is clamped on the natural reading for the given gradient.
- The natural tangents are 0.01,0.005,0.004 respectively.
- Hold the ranging rod by another person with target fixed at the height of the eye hole of the clinometer.
- Move up and down the slope, till target is bisected by the line of sight. (Fig 1)
- Peg the point ‘B’ on the ground.
- Shift the instrument to the point ‘B’ similarly other points C, D etc,.

Fig 1



LOCATING A CONTOUR GRADIENT WITH AN INDIAN TANGENT CLINOMETER

- Locate the contour point in a similar manner.
- The line of sight at points A,B,C,D etc., remain parallel to the lines of joining the points AB,BC,CD, etc,.

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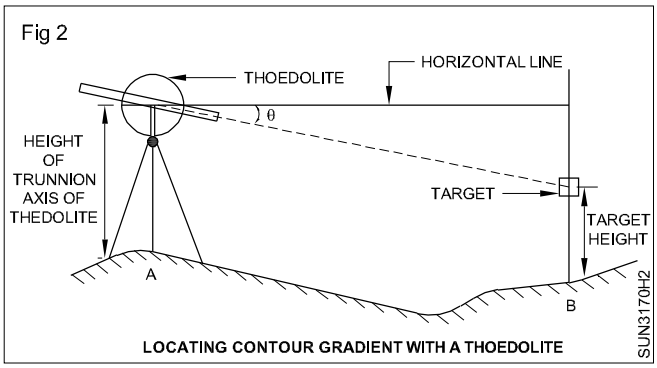
TASK 2: **Locating a contour gradient with a theodolite**

- Set up a theodolite the point ‘A’ (Fig 2)

Fig 2



LOCATING CONTOUR GRADIENT WITH A THOEDOLITE

- Level and center the theodolite over a starting point (A) of the contour gradient.
- Telescope points in the required direction of slope.
- Swing the telescope in the direction of proposed alignment of road.
- Measure the height (h) of the trunnion axis of the theodolite
- Fix a target to a rod at the same height is sighted.
- Bisect the target by the horizontal cross hair of the telescope.
- The position of the target is the required point on the contour gradient.
- Shift the instrument to the other point to obtained on the contour gradient.

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Preparation of 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

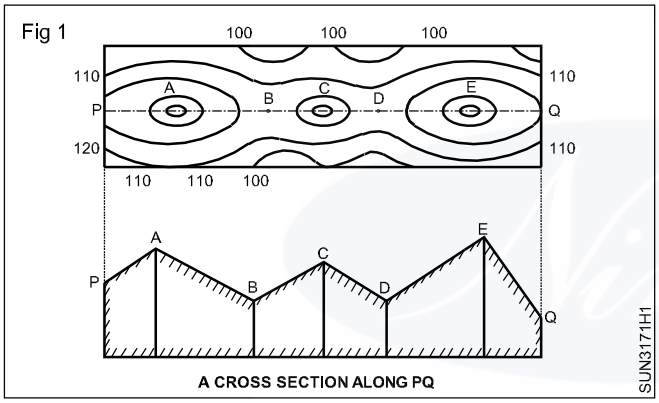
Materials

- Drawing sheet
- Pencil
- Eraser.

TASK 1: **Drawing of sections**

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

Fig 1



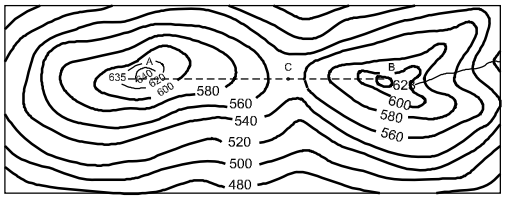
A CROSS SECTION ALONG PQ

- Plot the point at various contours intersect line PQ
- Draw Y - axis
- Draw their corresponding height are plotted to a convenient scale.
- The ends of the perpendiculars representing the contour height.
- Join the height by smooth straight lines, to give the configuration of the ground surface.

TASK 2: **Determination of intervisibility**

- A and B is given two points.
- The elevation obtained by interpolations of contours are 635 and 623 meters.
- Join AB by dotted line with pencil.
- Contour values decrease up to ‘C’
- Contour values increase up to point ‘B’
- No higher value contour appears in between the points A and B are intervisible.

Fig 2



INTERVISIBILITY OF POINTS

Computation of volume (prismoidal/trapezoidal)

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.

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 100 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,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

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

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

$$= 6312.75\ m^2$$

Prismoidal rule

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

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

$$= 6194.9\ m^3$$

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 foundation 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)

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 - reduced 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.

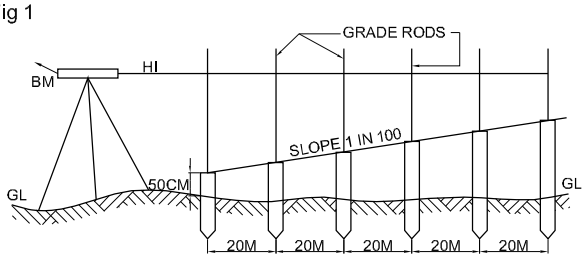
9 Direct the telescope towards the starting point and observe the staff reading.

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.

Fig 1



ESTABLISHMENT OF 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.**

PROCEDURE

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

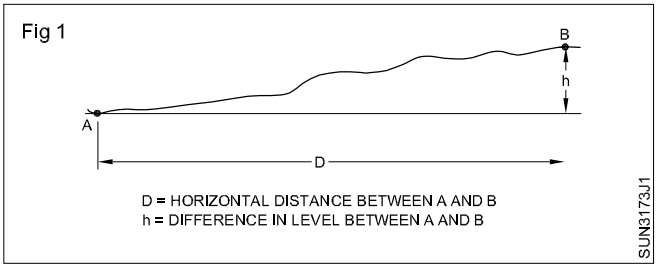
2 Calculate the reduced level of each station A and B.

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.

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 =

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

Ghat tracer

To trace the grade contour of gradient 1 in 50 along a hill slope

7 Let A and B are the points selected along a slope.

8 Hold the wooden staff on the station ‘A’.

9 Suspend the instrument from the pin in the wooden staff.

10 Slide the weight along the rack by means of milled headed screw until the index reads 50 on the scale.

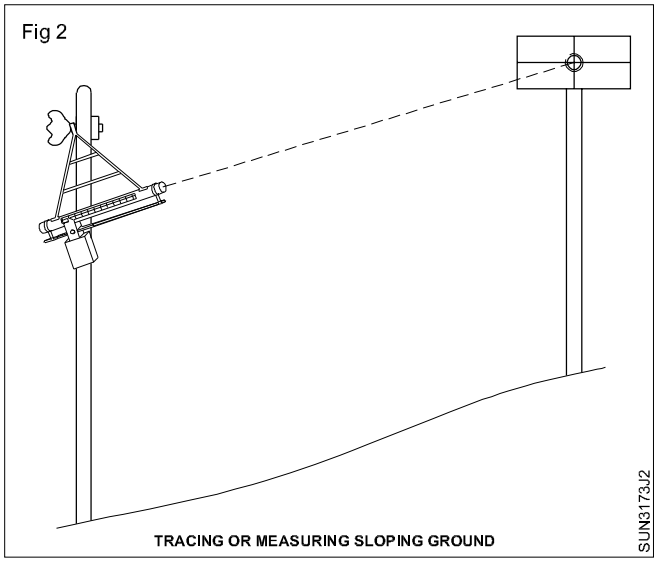
11 Send the assistant with sight vane to a particular point on the slope.

12 Look through the eye hole and direct the assistant to move up or down until the crosswire bisects the centre of the sight vane. (Fig 2)

The sight vane is a ‘T’ shaped staff on which the height of the axis of the suspending tube is marked.

13 Mark the foot of the sight vane with a peg.

This is the required point, and the line from the instrument station to this point lies on the gradient of 1 in 50.



14 Proceed to the point established and repeat the process to locate the next point.

15 Continue the process until the last point is established at ‘B’.

To measure a slope

16 Let ‘A’ and ‘B’ are the points on the slope

17 Hold the wooden staff at ‘A’

18 Suspend the instrument from the pin in the wooden staff.

19 Send the assistant to hold the sight vane at ‘B’. (Fig 2)

20 Slide the weight along the rack by means of milled headed screw until the centre of the sight vane is bisected by the crosswire.

21 Note the reading at the index edge of the weight, which gives the value of the slope.

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.

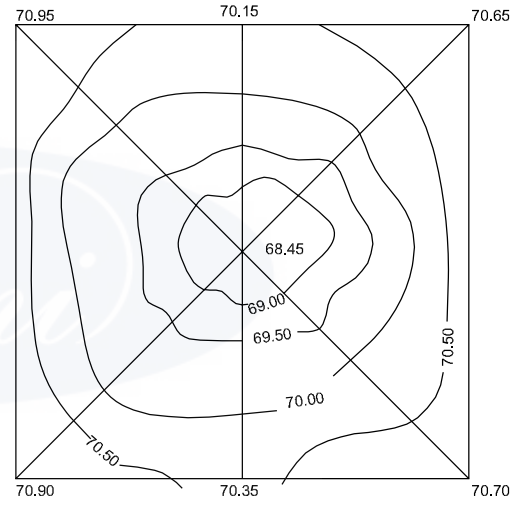
PROCEDURE

1 Follow the steps 1 to 10 exercise no 3.1.69

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

Setting out simple curve (by offsets from long chord) and computation

Objectives: At the end of this exercise you shall be able to
- **determine the elements 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
- Dumpy level with tripod
- Ranging rods, levelling staff, tape, pegs, hammer

Materials

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

PROCEDURE

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

R = 30 cm = 180° - 120° = 60°

1 Compute the elements of the curve

Tangent length = R tan $\theta/2$

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

Length of long chord (T1T2) = 2 R Sin 2 =2x30x sin 60/2 = 30 m

Mid offset or sine of curve = 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 = $\sqrt{(R^2-X^2} - (R-O^0)$

$O5 = \sqrt{(30^2-5^2)} - (30-4.02) = 29.58 - 25.98 = 3.60\,m$

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

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

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

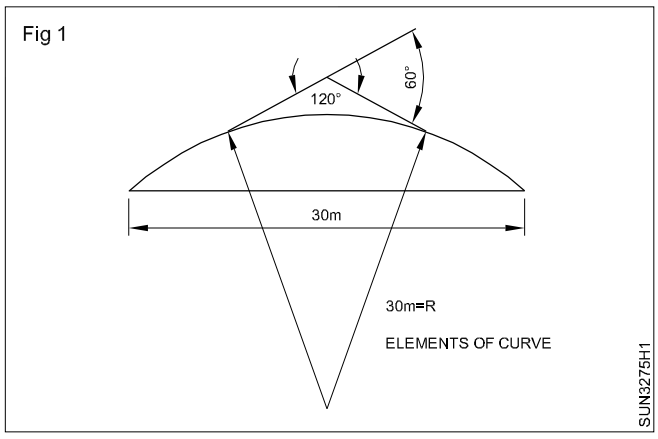
4 Join the points T1 and T2, which gives the long chord.

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

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

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

Fig 1



Setting of horizontal curve by linear method

Objectives: At the end of this exercise you shall be able to
- **determine the elements 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
- Dumpy level with tripod
- Ranging rods, levelling staff, tape, pegs, hammer

Materials

- Drawing sheet A2 size
- Field book
- Pencil eraser.

Horizontal curve setting by linear method

The following are the general methods employed for setting out curves by linear method.

Taking offsets or ordinates from the long chord.

Taking offsets from the chord produced.

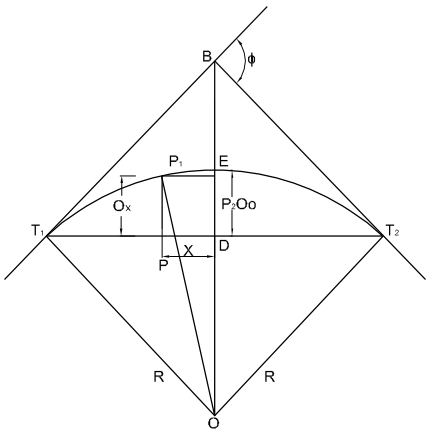
Successively bisecting the arcs.

Taking offsets from the tangents.

Offsets or ordinates from long chord

Let AB and BC be two tangents meeting at a point B, with a deflection angle φ. The following data are calculated for setting out the curve (Fig 1&2).

Fig 1



OFFSETS OR ORDINATES FROM LONG CHORD

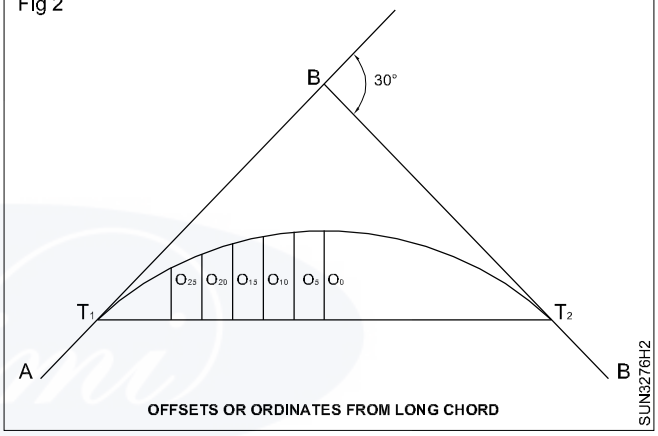
The tangent length is calculated according to the formula; TL = R tan ϕ/2.

Tangent points T_1 and T_2 are marked.

The length of the curve is calculated according to the formula;

$$CL = \frac{\pi R\varphi^\circ}{180^\circ}$$

Fig 2



OFFSETS OR ORDINATES FROM LONG CHORD

The chainages of T_1 and T_2 are found out.

The length of the long chord (L) is calculated from;

L=2R sin ϕ/2.

The long chord is divided into two equal halves the left half and the right half. Here the curve is symmetrical in both the halves.

The mid-ordinate O_0 is calculated as follows:

(a) O_0 = DE = versed sine of curve = R (1 - cos ϕ/2) (1)

(b) Again OF = R and OD = R - O_0

From triangle OT_1D, $OT_1^2 = OD^2 + T_1D^2$

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

$$\text{or} \quad R - O_0 = \sqrt{R^2/(L/2)^2}$$

$$\text{or} \quad O_0 = R - \sqrt{R^2 - (L/2)^2} \text{ ——— (2)}$$

Thus, the mid-ordinate O_0 can be calculated from Eq. (1) or (2).

Considering the left half of the long chord, the ordinates O_1, O_2..., are calculated distances X_1, X_2..., taken from D towards the tangent point T_1.

The formula for the calculation of ordinates is deduced as follows.

Let P be a point at a distance x from D. The PP_1 (O_x) is the required ordinate. A line P_1P_2 is drawn parallel to T_1T_2. From triangle OP_1P_2, $OP_1^2 = OP_2^2 + P_1P_2^2$.

or $R^2 = \{(R-O_0) + Ox\}^2 + x^2$ [Where, $OP_2 = (R-O_0) + O_x$]

$$\text{or} \quad R - O_0 + O_x = \sqrt{R^2 - X^2}$$

$$\text{or} \quad O_x = \sqrt{R^2 - x^2} - (R - O_0) \text{——(3)}$$

The ordinates for the right half are similar to these obtained for the left half.

Example Two tangents AB and BC intersect at a point B at chainage 150.5m. Calculate all the necessary data for setting out a circular curve of radius 100m and deflection angle 30° by the method of offsets from the long chord.

Solution

$$\text{tangent length} = R \tan \frac{\varphi}{2}$$

= 100 x tan 15° = 26.79m

Chainage of T_1 = 150.50 - 26.79 = 123.71m

$$\text{Curve length} = \frac{\pi R \varphi^\circ}{2} = \frac{3.14 \text{ x } 100 \text{ x } 30^\circ}{180^\circ} = 52.36\text{m}$$

Chainage of T_2 = 123.71 + 52.63 = 176.07 m

Length of long chord (L) = 2R sin ϕ/2

= 2 x 100 x sin 15° = 51.76m

The long chord is divided into two equal halves.

Each half = 1/2 x 51.76 = 25.88 m

$$\text{Mid-ordinate, } O_0 = R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$$

$$= 100 - \sqrt{100^2 - 25.88^2} = 3.41\text{m}$$

The ordinates are calculated at 5m intervals starting from the centre towards T_1 for the left half.

$$O_5 = \sqrt{R^2 - x^2} - (R - O_0)$$

$$\sqrt{100^2 - 5^2} - (100 - 3.41)$$

$$= 99.87 - 96.59 = 3.28\text{m}$$

$$O_{10} = \sqrt{(100^2 - 10^2)} - 96.59$$

$$= 99.50 - 96.59 = 2.91\text{m}$$

$$O_{15} = \sqrt{(100^2 - 15^2)} - 96.59$$

$$= 98.87 - 96.59 = 2.28\text{m}$$

$$O_{20} = \sqrt{(100^2 - 20^2)} - 96.59$$

$$= 97.97 - 96.59 = 1.38\text{m}$$

$$O_{25} = \sqrt{(100^2 - 25^2)} - 96.59$$

$$= 96.82 - 96.59 = 0.23\text{m}$$

$$O_{25.88} = \sqrt{(100^2 - 25.88^2)} - 96.59 = 0 \quad \text{(Checked)}$$

The ordinates for the right half are similar to those for the left half.

Exercise

Compute the offsets from long chord at 10m interval for a simple curve of radius 400m, length of long chord is 100m.

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

- Theodolite with tripod - 2 Nos
- Ranging rods, pegs, hammer

Materials

- Field book, pencil, eraser

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

1 Compute the elements of the curve.

R = 60 cm, $=\theta 180° - 120° = 60°$

Tangent length = $BT_1 = BT_2 = R \tan\theta = 60 \tan 60/2 = 34.64$m.

Length of long chord (T_1T_2) = 2 R Sinθ/2 = 2x60x sin 60/2 = 60m

$$\text{Arc length} = \frac{\pi R\theta}{180} = \frac{\pi x60x60}{180} = 62.83\text{m}$$

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

$$= \frac{8.83x180}{2x60x3.14}$$

$\blacktriangle_T$ = 4° 12' 57.65" i.e 4°13'

Tangential angle for normal chord =

$$= \frac{9x180}{2x60x3.14} = 4°17'49.86"$$

Deflection angle for second chord

$\blacktriangle_T$ = 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

$\blacktriangle_3 - \blacktriangle_2 + \blacktriangle_1$ = 8°30'47.51" + 4°17'49.86" = 12°48'37.37" = 12°48'40"

Deflection angle for fourth chord

$\blacktriangle_4 = \blacktriangle_3 + \blacktriangle_1$ = 12°48'37.37"+ 4°17'49.86" = 17°6'27.23" = 17°6'20"

Similarly total deflection angle for fifth chord

$\blacktriangle_5 = \blacktriangle_4 + \blacktriangle_1$ = 17°6'27.23" + 4°17'49.86" = 21°24'17.09" = 21°24'20"

Similarly total deflection angle for sixth chord

$\blacktriangle_6 = \blacktriangle_5 + \blacktriangle_1$ = 21°24'17.09" + 4°17'49.86" = 25°42'0"

Similarly total deflection angle for seventh chord

$\blacktriangle_7 = \blacktriangle_6 + \blacktriangle_1$ = 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 thodolite 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.

Setting out a compound curve

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

Requirements

Tools/Equipments/Instruments

- Theodolite with tripod stand

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
- $\Delta 1$ - Deflection angle of IKL
- $\Delta 2$ - Deflection angle of ILK
- RS - Radius of arc small T1C
- RL - Radius of arc large T2C
- TS - Total tangent length small - T1I
- TL - Total tangent length large - T2I
- Angle T_1, O_1, C = 180 - angle T_1 KC = $\Delta 1$
- 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 charge of point of commencement (ie) chainage of T_1 = Chainage of I - Tangent length of T_1I
- Calculate the chainage point of curvature (ie) chainage of C = Chainage of T_1C + Length of arc T_1C which is $= \frac{\pi RS\Delta 1}{180^\circ}$
- Calculate the chainage point of tangency (ie) chainage of T2 = Change of 'C' + Length of arc 'T2C' which is $= \frac{\pi RL\Delta 2}{180^\circ}$
- Calculate deflection angle for both the arcs from their tangents (ie) $\delta = \frac{1718.9C}{R}$

Where: C is chord length

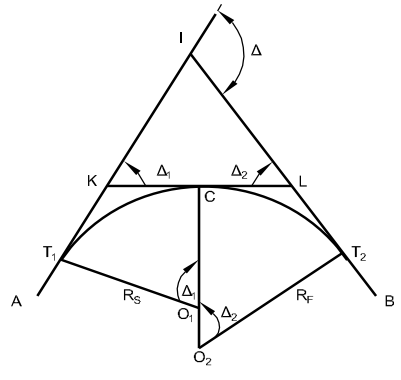
R = Radius if arc

— — — — — — — —

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 3.2.77)
- Shift the theodolite and set up at point 'C'
- Set the vernier 'A' (360° - $\Delta 1/2$) or $\Delta 1/2$ 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

Fig 1



GEOMETRIC OF A COMPOUND CURVE

SUN3278H1

- 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.

— — — — — — — —

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 :

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

$$= 180° - \frac{\Delta 1 + \Delta 2}{2}$$

$$= 180° - \frac{\Delta}{2}$$

— — — — — — — —

Elements of a reverse curve and set out of reverse curve

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

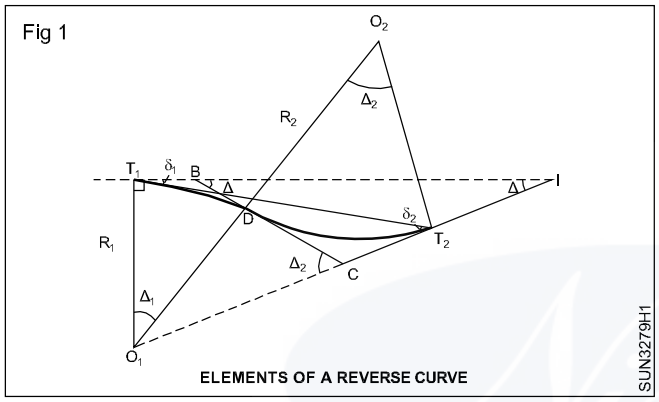
- Theodolite with tripod
- Ranging rods
- Tape

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

- Set out and setting the theodolite
- T_1O_1 and T_1I are two straight line, where T_1 common point
- R_1 and R_2 are two circular area and equal
- Δ = angle of total deflection of the straights.
- $\Delta 1$ and $\Delta 2$ are equal deflection angles of common tangents.
- Angle ($\delta 1 \delta 2$) between the straight and the line joining the points of commencement and tangency.
- The length of line joining the tangent points is known

— — — — — — — —

TASK 2 : **Construction of reverse curve**

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.

The angles S_1 & S_2 between the line T_1 and T_2 and back straight to T_1B forward straight CT_2 respectively.

Now find common radius R.

Specified condition: $R_1 = R_2 = R$

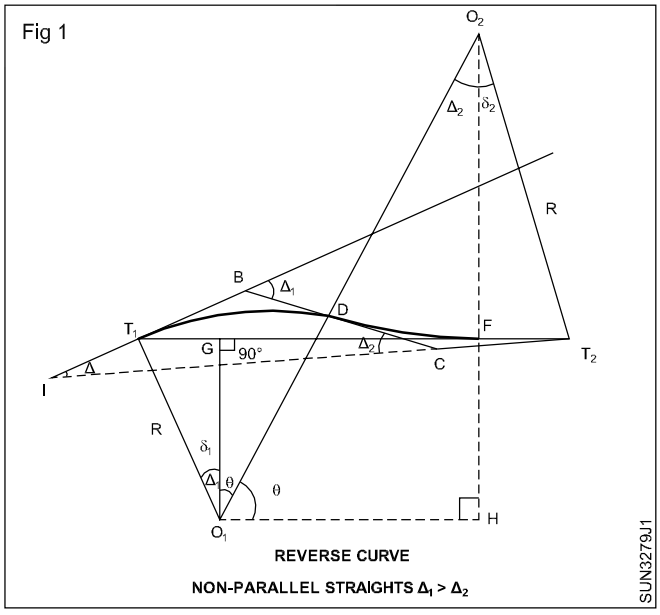
Let T_1 & T_2 be two tangent points. O_1 & O_2 centres of circular arcs. Distance T_1 and T_2 be equalent to L.

Construction:

Draw O_1G & O_2F perpendicular to T_1 T_2 and Q_1H perpendicular to O_2F produced.

Assume angle O_2O_1H be Q

Fig 1



REVERSE CURVE

NON-PARALLEL STRAIGHTS $\Delta_1 > \Delta_2$

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

$Q_1G = R \cos \delta_1 = FH$

$O_2F = R \cos \delta_2$

$\therefore O_1O_2 = 2R.$

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

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

$$= \theta = \text{Sin}^{-1}\frac{\text{Cos}\,\delta_1 + \text{Cos}\,\delta_2}{2}$$

now F G = R sin δ_1

GF = O_1H = 2R cosθ

FT_2 = R Sin δ_2

substitute the value in

L = R Sin δ_1 + 2R cos θ + Sin δ_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° - θ)

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

— — — — — — — —

$\therefore$

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
- Theodolite with tripod
- Ranging rod, pegs, hammer

Materials
- Field book
- pencil eraser.

PROCEDURE

- Take a convenient length of the transition curve.
- Calculate the length.
- Calculate the amount of the shift $S = \frac{L^2}{24R}$
- Calculate the total tangent length = (R+S) $\tan\frac{\Delta}{2} + \frac{L}{2}$
- Locate the point of commencement and tangency by measuring their 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 $x = \frac{Y^3}{6RL}$

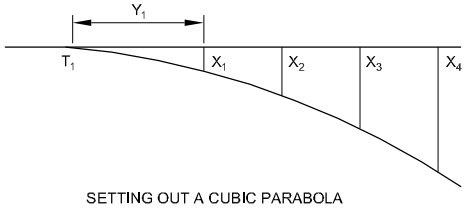
ii Cubic spiral transition curve $= x = \frac{l^3}{6RL}$

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)
- 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 on the transition curve on the ground.

Fig 1



SETTING OUT A CUBIC PARABOLA

Setting a transition curve by offset method :

$$x = \frac{y_3}{6RL} =$$

Assume Radius = 350m (R)

Length of curve = 150 (L)

Y = 0m $\quad \therefore$ X = 0

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

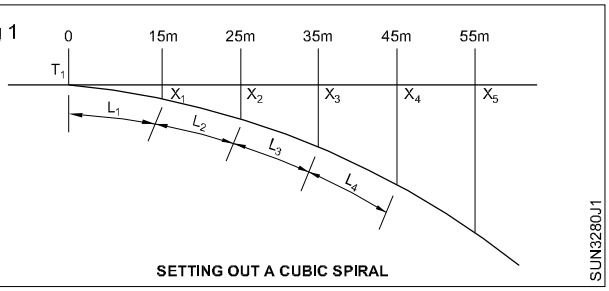
$$x_2 = 25m = \frac{25^3}{6x350x150} = 0.049m$$

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

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

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

Fig 1



SETTING OUT A CUBIC SPIRAL

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**

- OX and OY is the axes of the rectangular ordinates, passing through beginning (o) of the vertical curve (Fig1)
- OA = Tangent having + g_1% slope
- AB = Tangent having - g_2% slope
- Q = Any point on the curve having co-ordinates (x,y)
- 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)

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

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

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

PQ = PR - QR

But, PR = g_1 x and QR = Y

PQ = h = g_1x - y

substitute in $xg_1 - y = ax^2$

$g_1 x - y = -a_1x^2$

$-ax^2 = Cx^2 = h = h = KN^2$

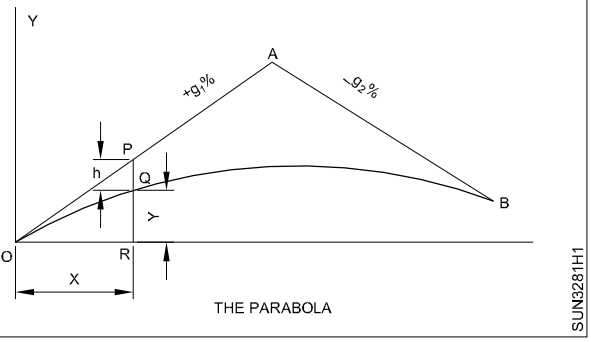
Where C = Constant

K = Constant

N = Distance measured from the beginning of curve.

Note: The elevations 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 elevations the tangent corrections.

Fig 1



— — — — — — — —

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

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

$zp = ne_1$

$py = -ne_2$

$yz = pz + py = n (e_1 - e_2)$

From $h = kn^2$

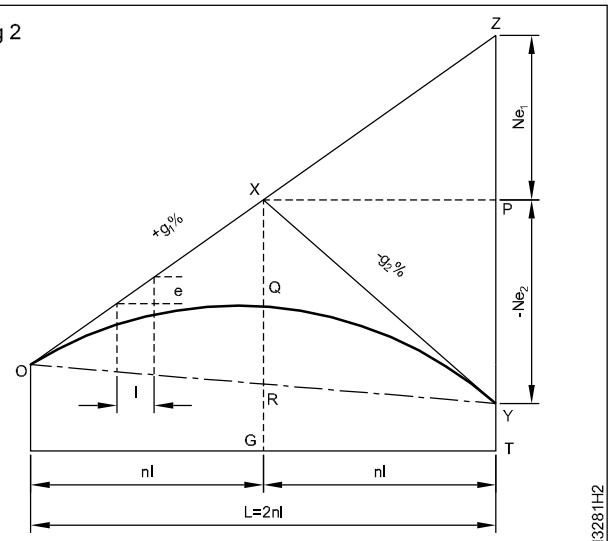
$yz = KN^2$ (where $N = 2n$)

$K (2n)^2$

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

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

Fig 2



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

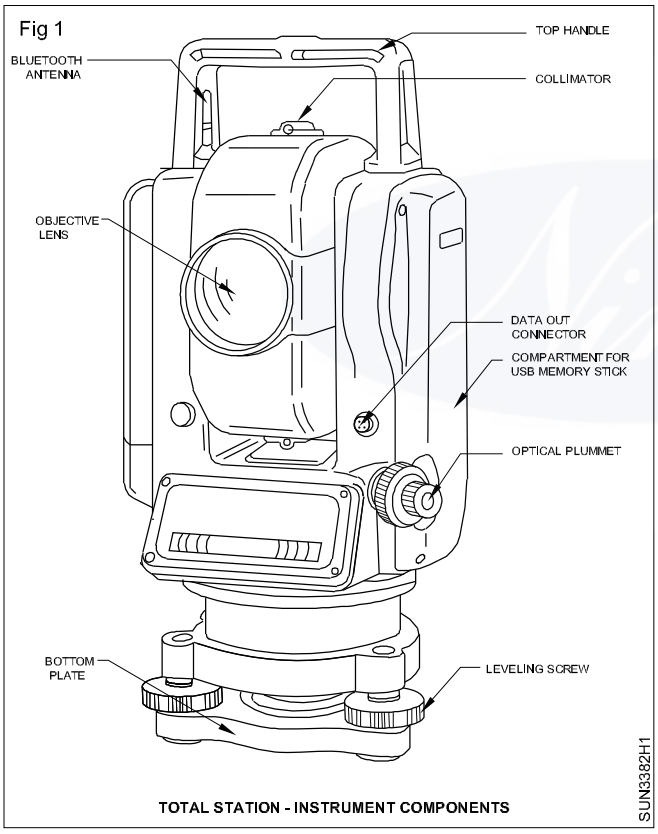
Tools/Equipments/Instruments

- Total station in carrying box with tripod
- Computer with CAD software
- Printer

Materials

- Paper A4 size.

PROCEDURE



TOTAL STATION - INSTRUMENT COMPONENTS

Set up

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

1 Choose as adequate instrument station. Make sure that an observe can safely operate the instrument with out 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 instrument, which is the point of intersection if the transverse axis and the vertical axis if 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 is the 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 eyepiece. 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 without 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 the centre using the plummet.

5 To occupy an existing a station above a reference point, first roughly develop the tripod head right above the point. For levelling up a 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 roughtly levelled and centered push each tip of the period 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 a plummet, a tribrach and a prism carrier with a plummet or a total station with a built-in plummet on the tripod head.

9 Adjust the three screws of the branch to centre the bubble of a spirit level with the following steps;

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

d Rotate 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 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, the 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 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).

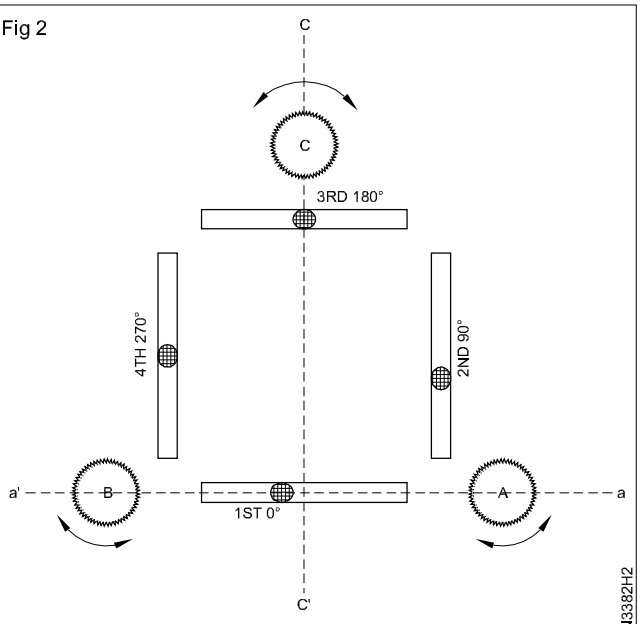
10 Pull out of the optical plummet and use the optic ring to focus and the graticule and then focus at the mark on the ground. Or turn the laser plummet. Rotate the plummet or the total station to check, it is centered within 1cm from the reference point. If not, estimate the amount of offset and carefully translate the entire tripod as much as the offset. Return to 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 in the branch 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

Fig 2



FINE LEVELLING PROCEDURE

of centre of the reference. Slightly loosen the fixing screw below the tripod head and translate the tribrach to place the plummet center on the exact point. Do not rotate. When the translation 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 alidade. 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.

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.**

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

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** (↵)

Specify first point: **20, 20** (↵)

Specify first point or [Undo] : **100,20** (↵)

Specify next point or [Undo]: **100,50** (↵)

Specify next point or [Close/Undo] : **90,50** (↵)

Specify next pont or [Close /Undo] : **86, 65** (↵)

Specify next pont or [Close /Undo] : **75,65**(↵)

Specify next pont or [Close /Undo] : **70,50** (↵)

Specify next pont or [Close /Undo] : **50,50** (↵)

Specify next pont or [Close /Undo] : **30,65** (↵)

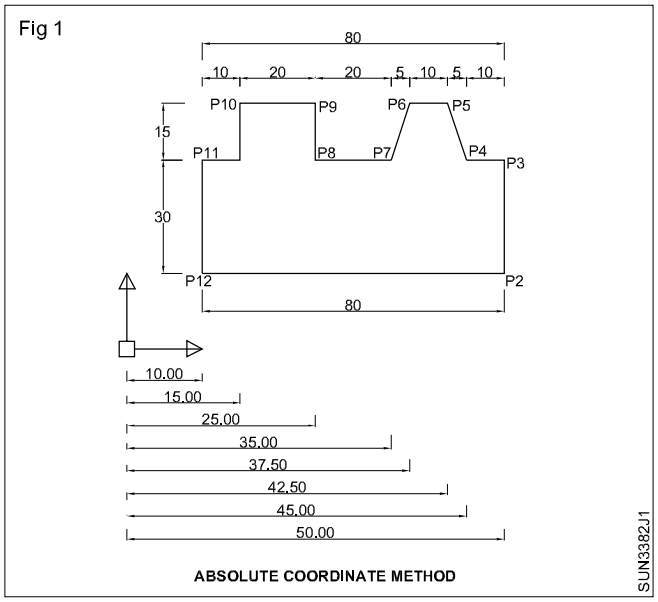
Specify next pont or [Close /Undo] : **30, 50** (↵)

Specify next pont or [Close /Undo] : **20, 50** (↵)

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

4 Save this file.

Fig 1



ABSOLUTE COORDINATE METHOD

Output

— — — — — — — —

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

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** (↵)

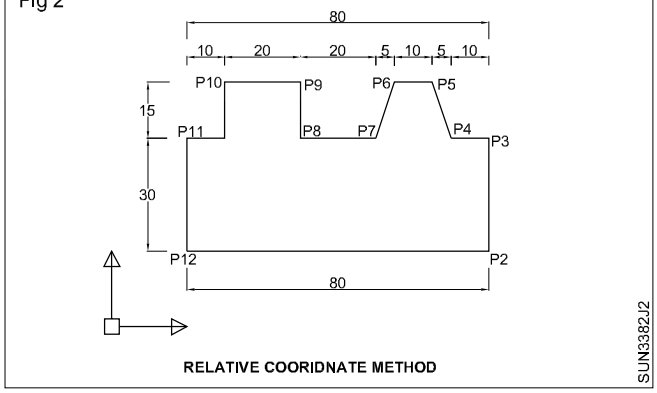
Specify next point or [Close/Undo]:@ **-10,0** (↵)

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

4 Save this file.

Output

Fig 2



RELATIVE COORIDNATE METHOD

— — — — — — — —

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

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** (↵)

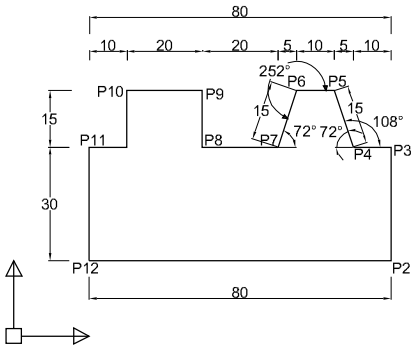
Specify next point or [Close/Undo]:@ **4.27<270** (↵)

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

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

4 Save this file.

Fig 3



POLAR COORDINATE METHOD

Output

— — — — — — — —

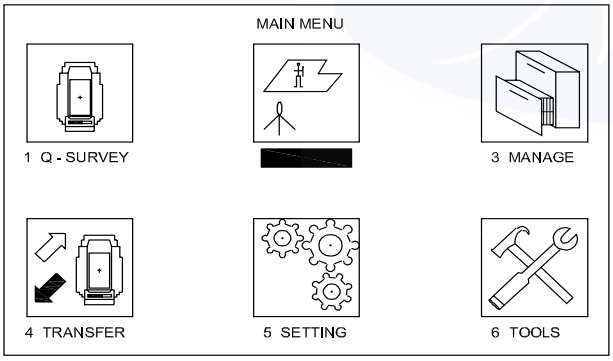
Station setup for a total station

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.**

PROCEDURE

- After centering and levelling (done in previous Exercise) Press MENU
- Press (**Programs**).(Fig 1)

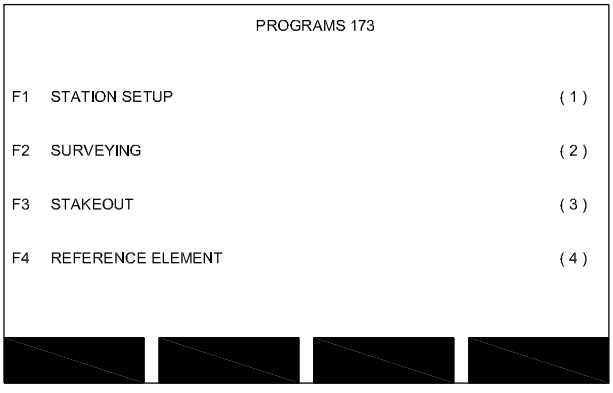
Fig 1



LEVELLING & CENTERING

- Press F1 (Station setup) (Fig 2)

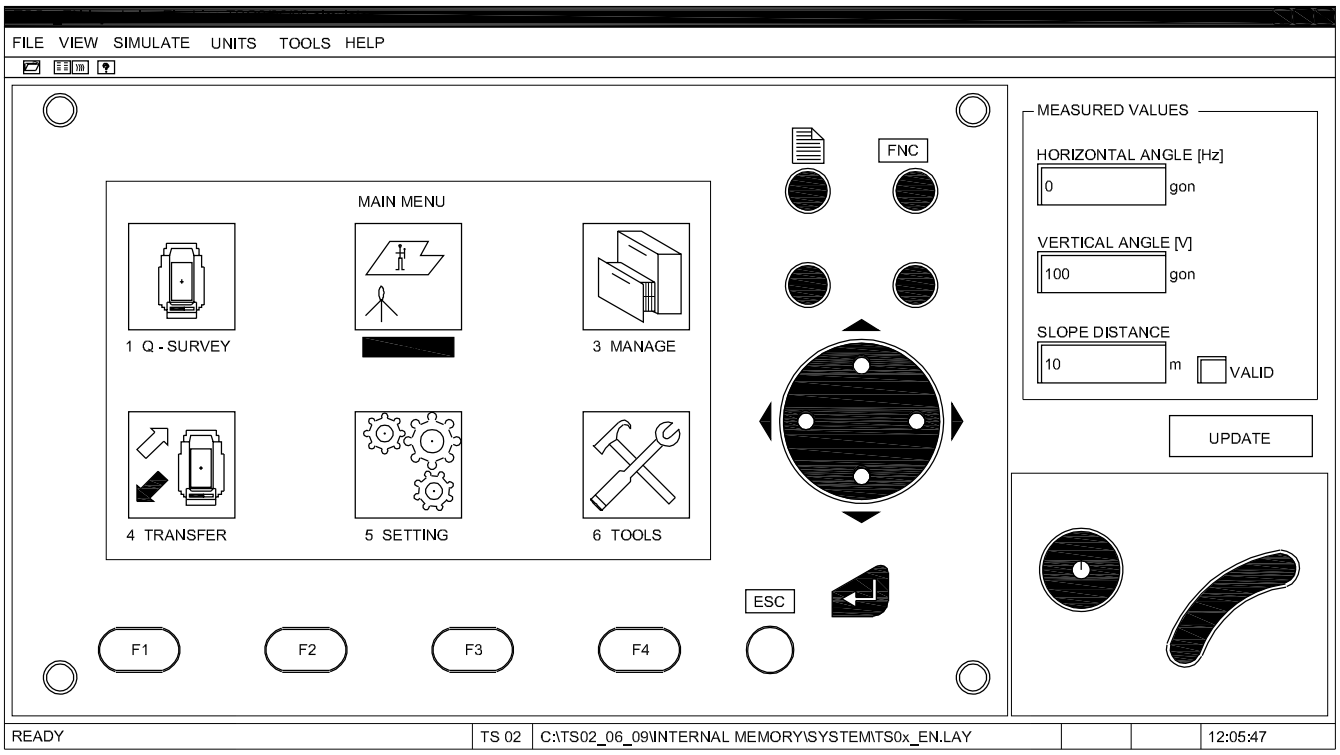
Fig 2



LEVELLING & CENTERING

- Switch on the instrument. (Fig 3)
- Press FNC key Laser Beam for centering and levelling.
- 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 F1 (INPUT) and then using Keyboard give the name and then Press Enter Key. (Fig 8)
- Press F4 (OK) (Fig 9)
- Press F2 (Set Accuracy Limit) (Fig 10)
- Press F4 (OK) OR you may give some accuracy limit. (Fig 11)
- Press F4 (OK)(Fig 12)
- Press F4(OK)(Fig 13)
- Now select the method of orientation suppose you are selecting the back side coordinate Method and Press F3 New station.(Fig 14)
- Now give Station Point ID and give the Easting, Northing & Height using key board and press F4 (OK). (Fig 15)
- Now bring the cursor on instrument height hi and measure the instrument height and give the height. Press F4 OK.(Fig 16)

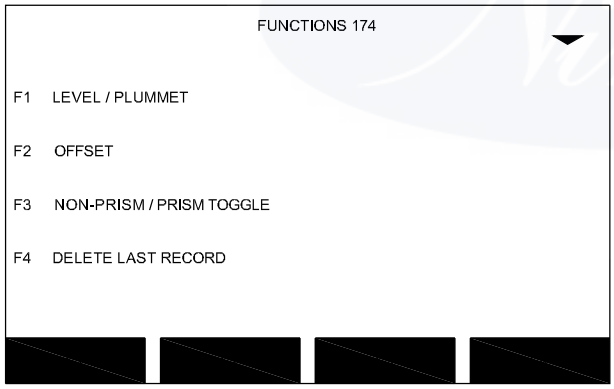
Fig 3



SUN3382X3

LEVELLING & CENTERING

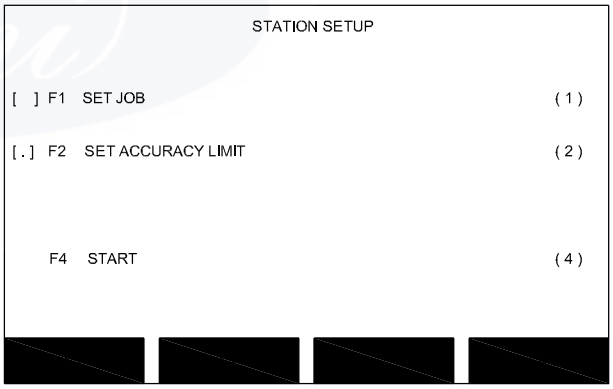
Fig 4



SUN3382X4

LEVELLING & CENTERING

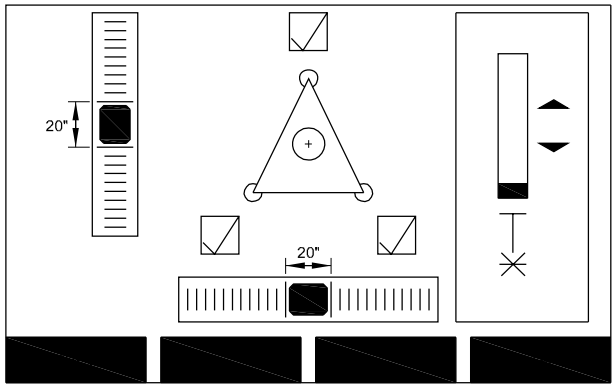
Fig 6



SUN3382X6

LEVELLING & CENTERING

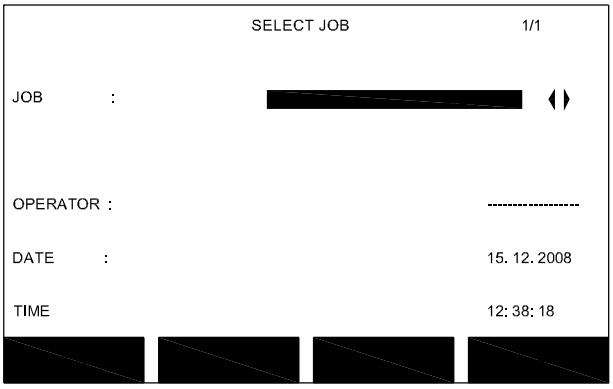
Fig 5



SUN3382X5

LEVELLING & CENTERING

Fig 7



SUN3382X7

LEVELLING & CENTERING

Fig 8

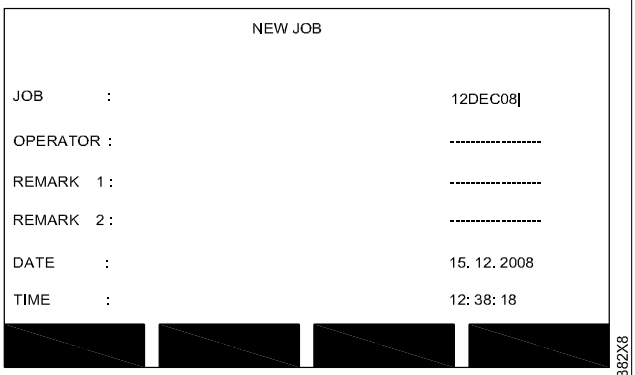


Fig 9

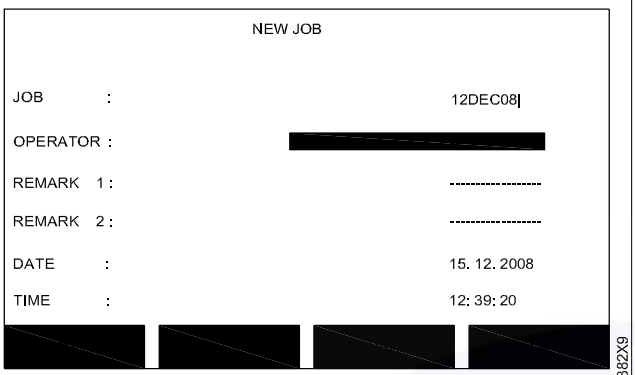


Fig 10

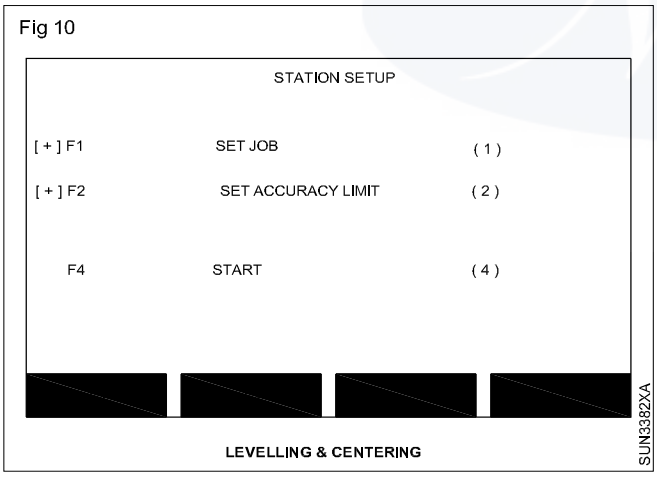


Fig 11

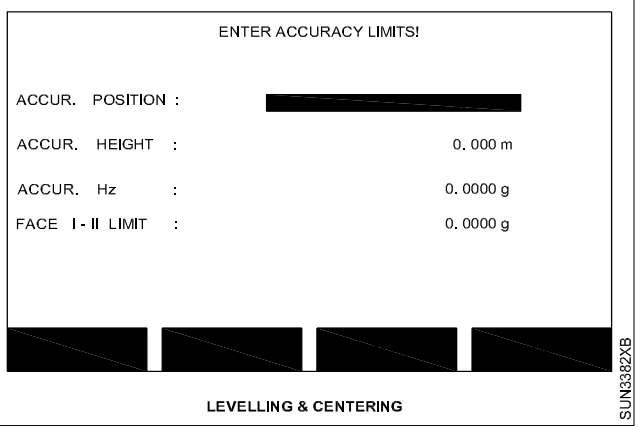


Fig 12

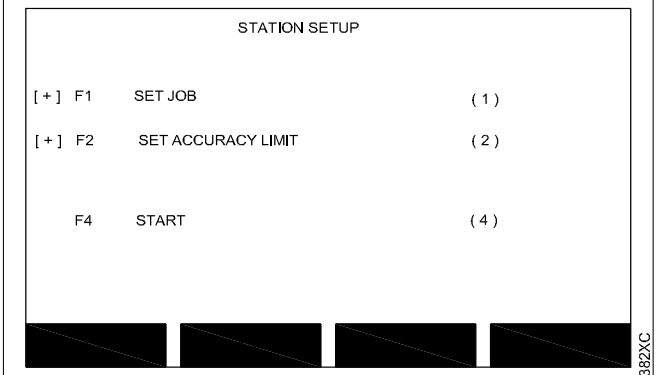


Fig 13

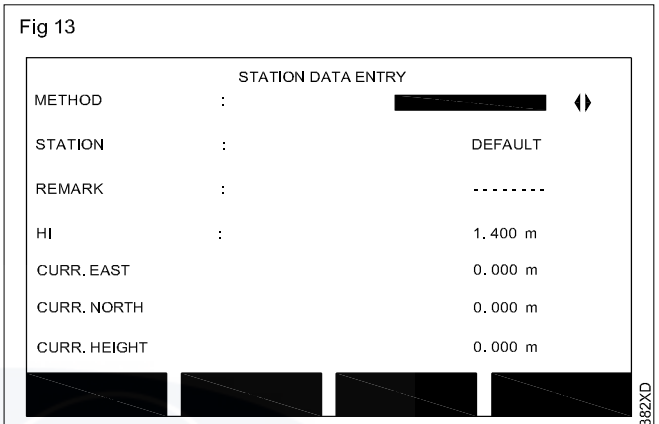


Fig 14

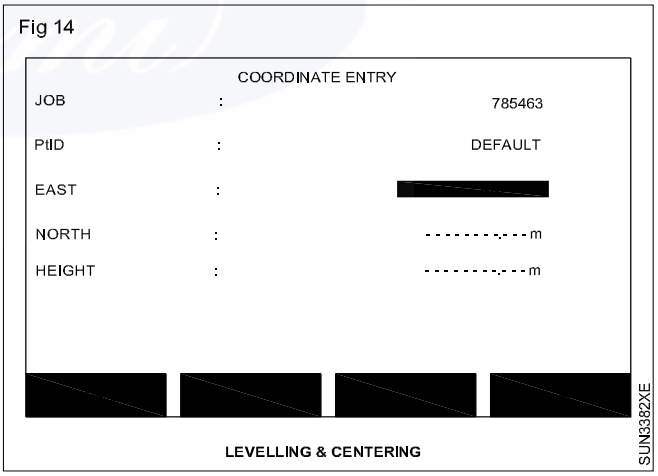


Fig 15

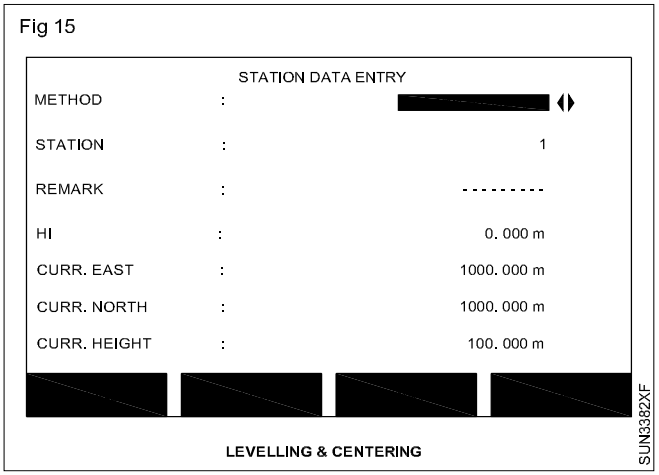
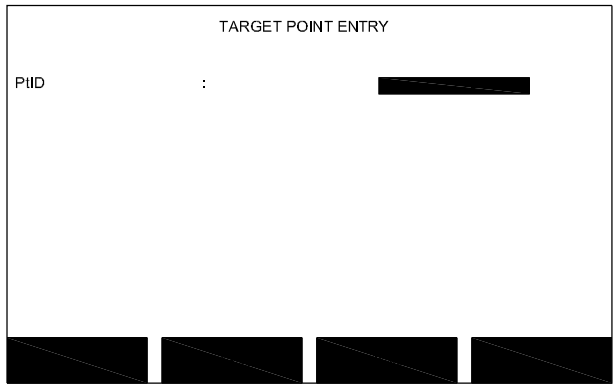
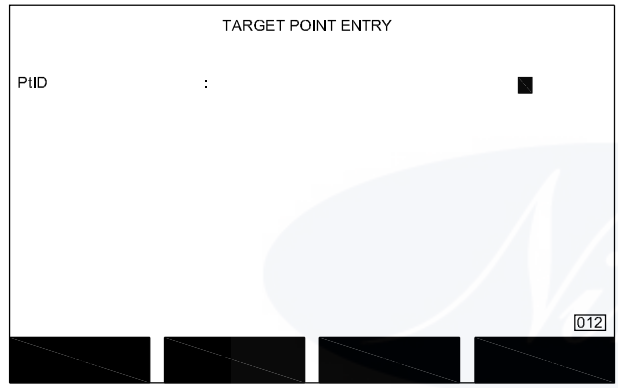


Fig 16



- Now give the back side point ID or you can select from list if back side ID is stored in memory and you can also give the new number of point ID pressing New F3 and give the coordinate. Suppose your backside point ID is 2.(Fig 17)

Fig 17



- Press Enter.(Fig 18)
- Press F4.(Fig 19)
- Press F3 (ENH).(Fig 20)
- Give the Easting, Northing and Height of Back side point ID and press F4 OK. (Fig 21)
- Now give reflector height prism say (1. 300m) and sight the prism press DIST you can see your error in then press REC.(Fig 22)
- Press F4 Compute.(Fig 23)
- Press F4 SET now your station and orientation has been set. After that you can do any program suppose you are doing surveying.
- In main menu bring the cursor to program icon and press Enter key. (Fig 24)
- Now press F2 surveying.(Fig 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 in setup is same for all programs.

Fig 18

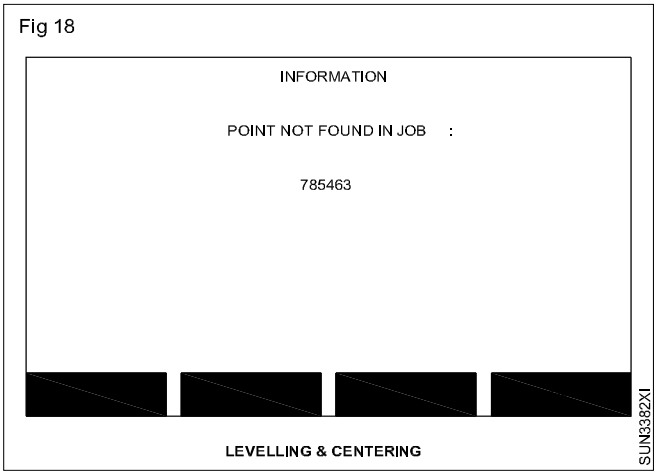


Fig 19

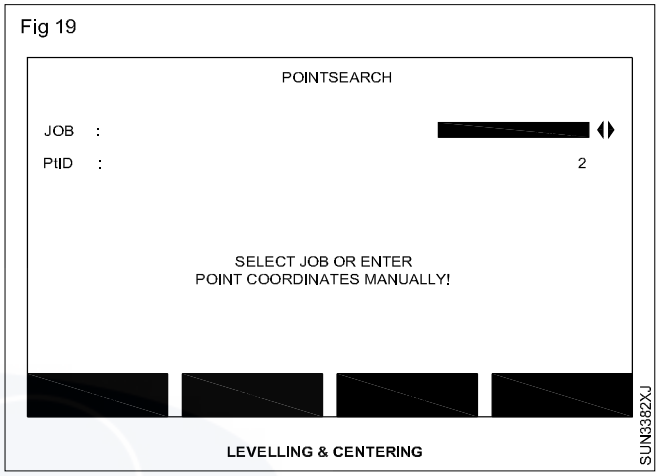


Fig 20

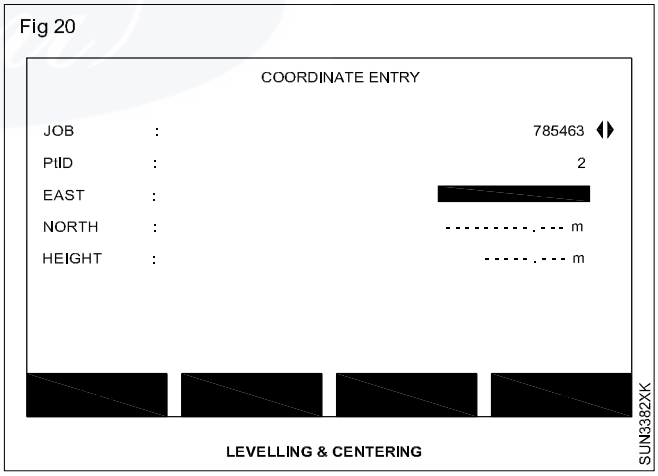


Fig 21

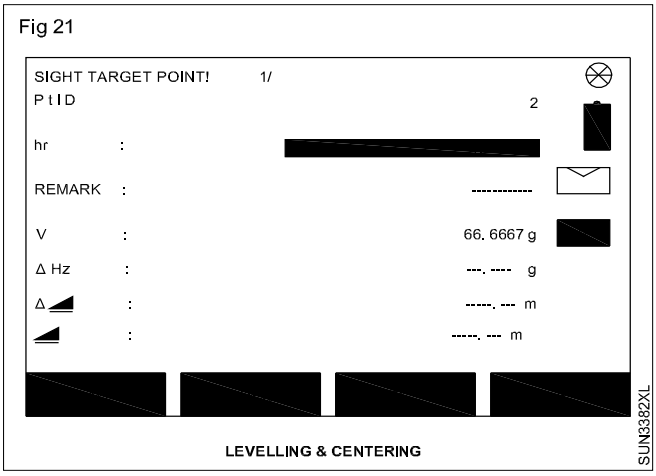


Fig 22

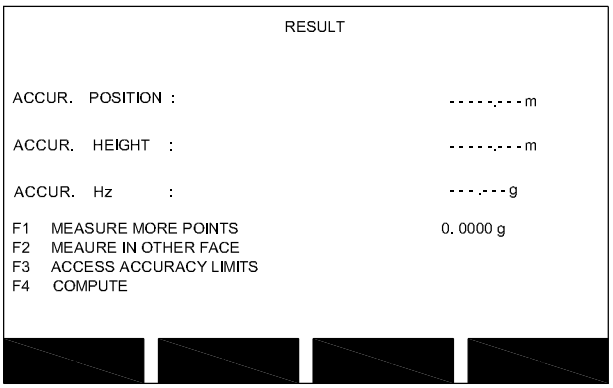


Fig 23

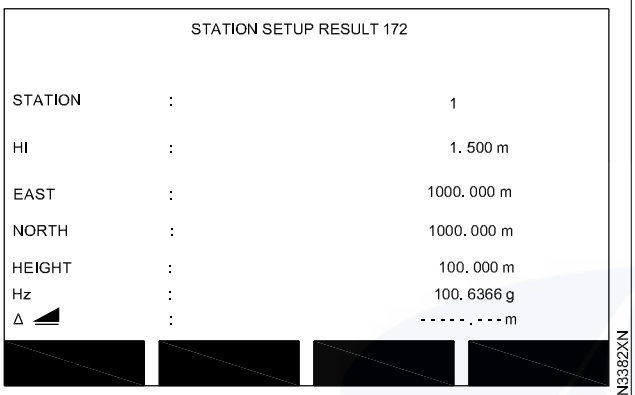


Fig 24

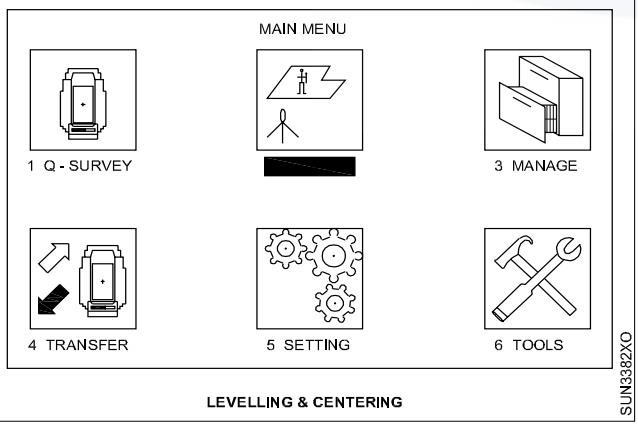


Fig 25

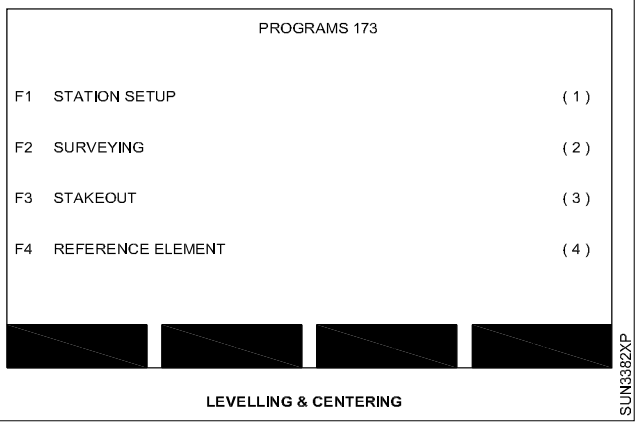


Fig 26

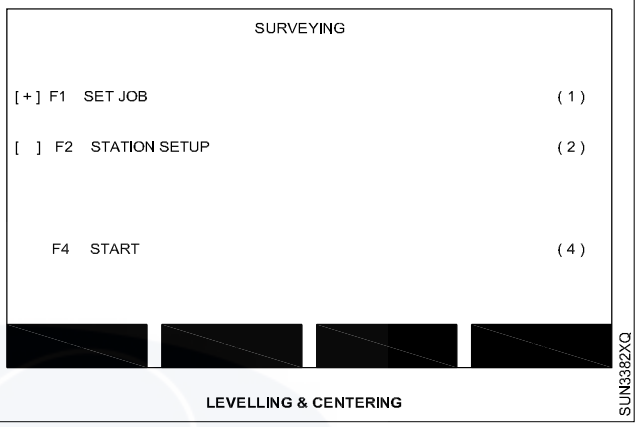
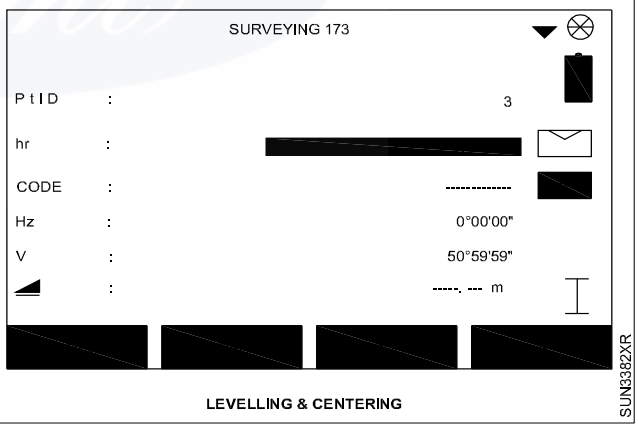


Fig 27



Setting out using total station

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

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

PROCEDURE

- Establish the total station. Do the centering and levelling. Do the station set up.
- In main menu, bring the cursor in program and press Enter key. (Fig 1 & 2)
- Press F3. (Fig 3)
- Press F1 set job.(Fig 4)
- Press F1 New and give job name or chose the job from memory and press F1 ok. (Fig 5)

Fig 1

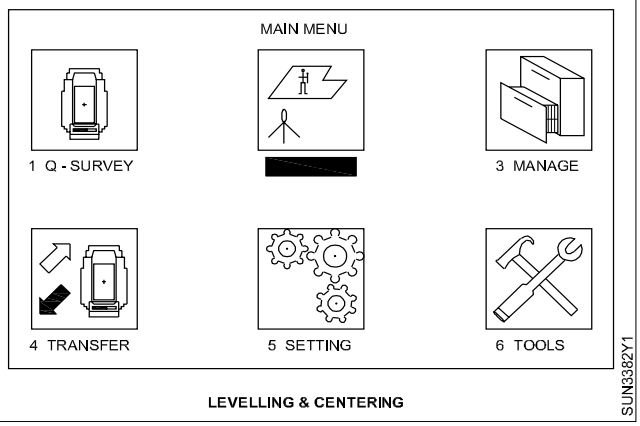


Fig 2

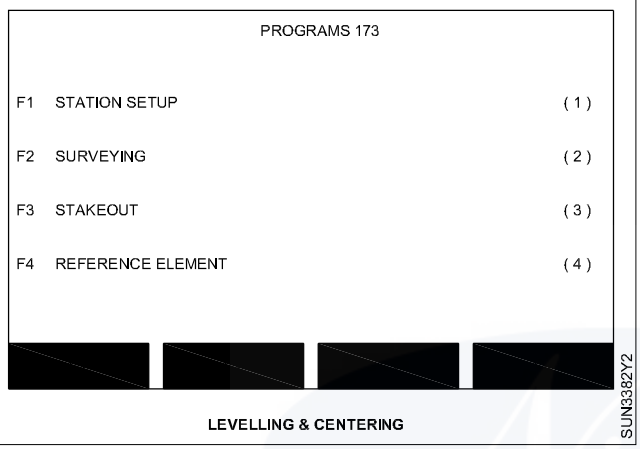


Fig 3

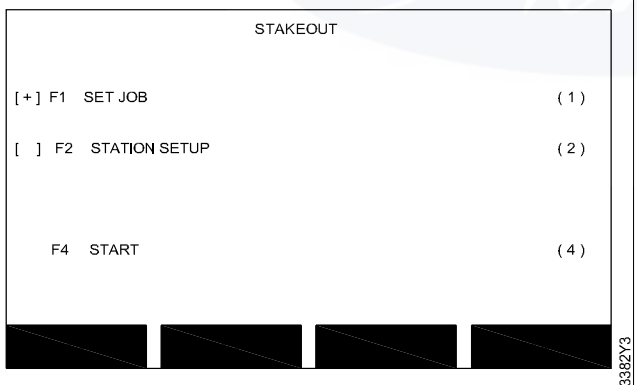


Fig 4

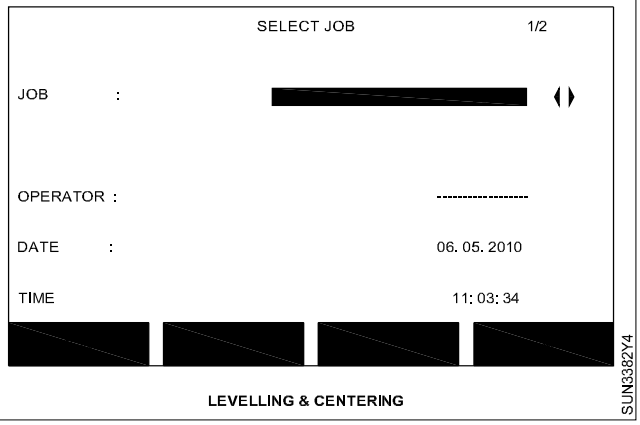
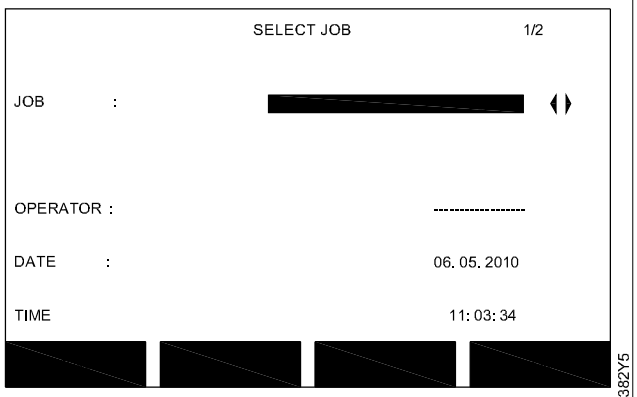


Fig 5



- Press F4 ok. (Fig 6)
- If your station setup is already done then press F4 start. (Fig 7)
- After that select the point ID from memory. It will indicate angle & distance. Make the angle zero with the help slow key.
- 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.(Fig 10,11)
- Now it is same as before.

Fig 6

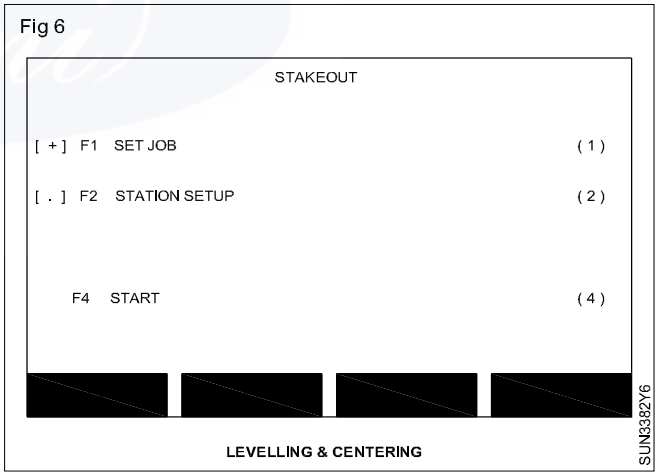


Fig 7

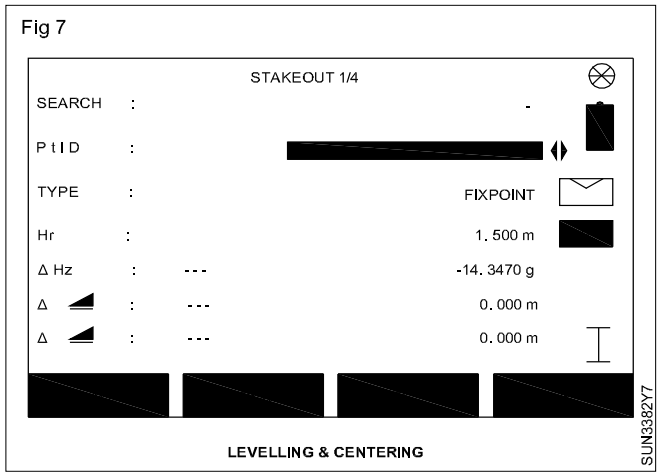


Fig 8

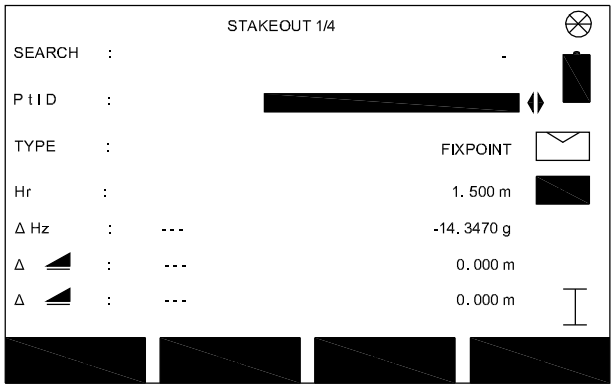


Fig 9

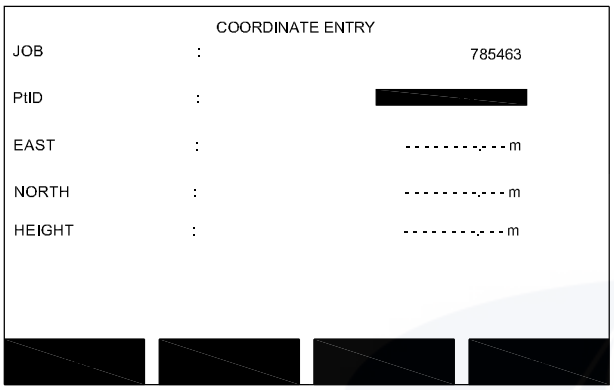


Fig 10

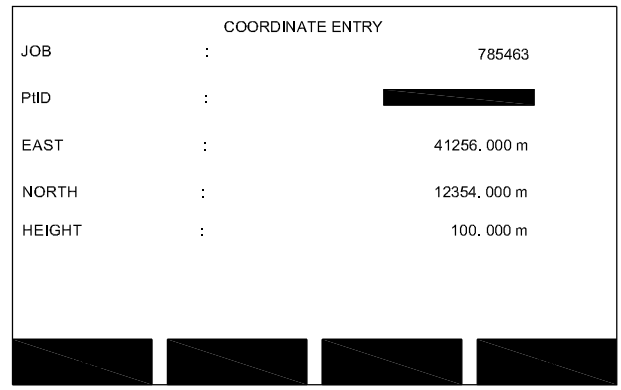
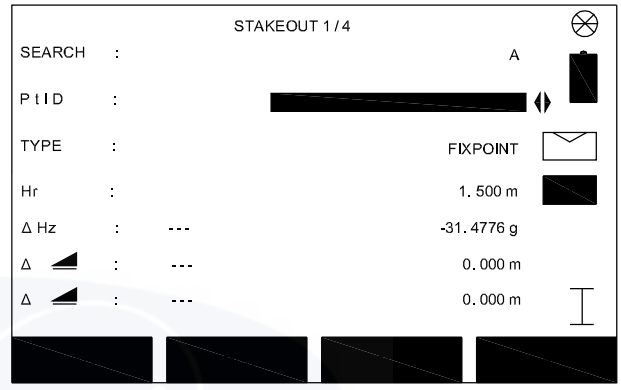


Fig 11



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

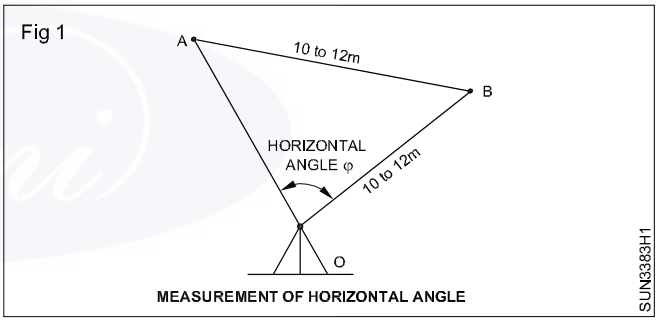
- Survey note book - 1 No.
- Pencil - 1 No.
- Eraser - 1 No.

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

- Select the sight for taking horizontal angle.
- Set the instrument at 'O' and complete the temporary adjustment.
- Set the instrument in north and carry north through survey by using back sights.
- Set the instrument measured from zero direction on the horizontal scale.
- At the same time, the instrument show true north
- Select a point 'A' and fix a ranging rod at 'A'
- Set the zero direction.
- Sighting to another B.M
- Fix another point 'B'
- Sight 'B' by turning the instrument horizontally.
- Note down the reading in degrees.
- ∠AOB is the horizontal angle of the two station point AB (Fig 1).

The least reading of horizontal vertical angle is 5sec.

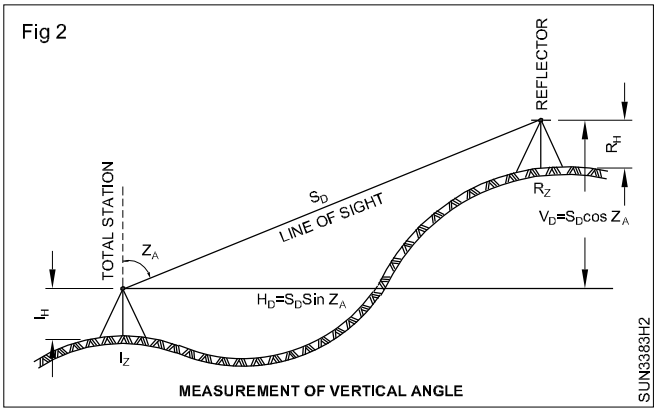
Fig 1



MEASUREMENT OF HORIZONTAL ANGLE

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

Fig 2



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

IH = Instrument height

RH = Reflector height

IZ = Ground elevation of Total station

RZ = Ground elevation of Reflector

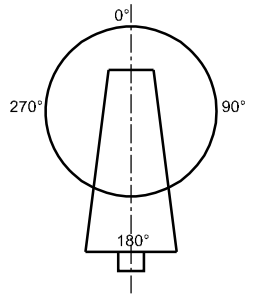
Vertical angle = 180° - ZA

- Select the site to measure vertical angle by total station
- 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 defect small divisions of verticality.

- The vertical angle is usually measure as a zenith angle. ‘O’ vertically up, 90° horizontal and 180° vertically down (Fig 3).
- Fix target ‘R’ for the vertical angle.
- Turn the telescope to sight the target ‘R’ from zenith position.

Fig 3



ZENITH POSITION

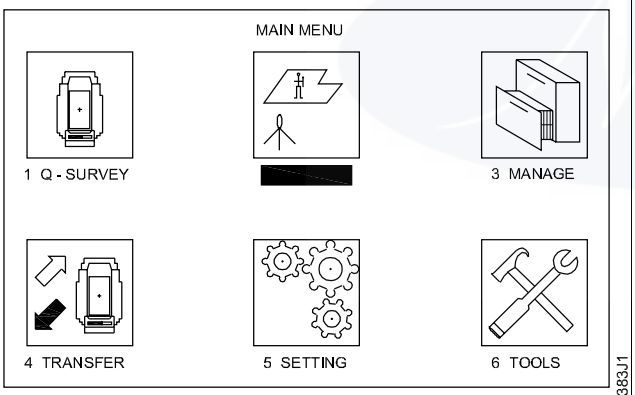
Resection using total station

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

PROCEDURE

- Establish the total station. Do the centering and leveilling. 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
- Press F1 (Programs). (Fig 1)

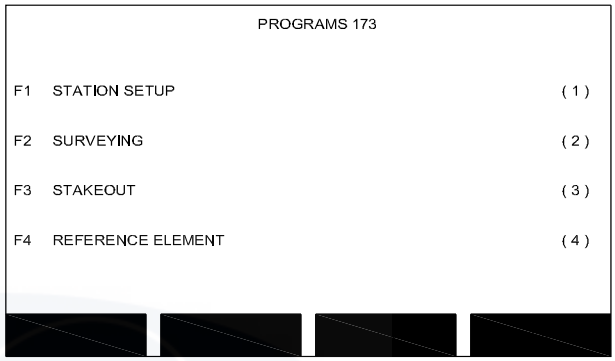
Fig 1



LEVELLING & CENTERING

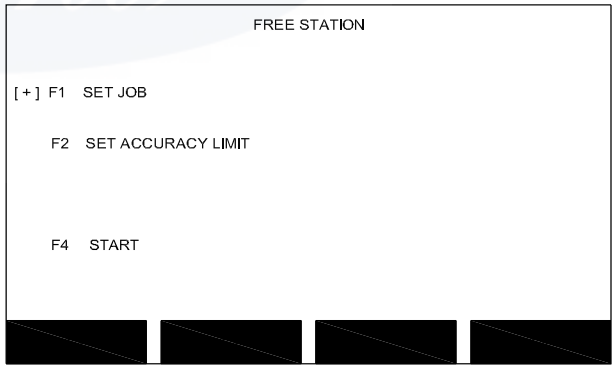
- Press F1 (Station set up). (Fig 2)
- Press F1 (Set job) (Fig 3)
- Enter the Name of the job by Pressing F1 (INPUT)and the using the function keys F1 to F4; enter the name of the job.
- Press F4 (Start).
- In front of the method select Resection with the help of navigation key and press F4 ok. (Fig 4 & 5)
- Now we can give the coordinate of the pt ID by pressing new F3 key.
- In front of the point ID enter number of the first Point where the Prism is kept. (Fig 6)
- In front of hr (Height of the Reflector) enter the height to which the prism pole is opened.(Fig 7)

Fig 2



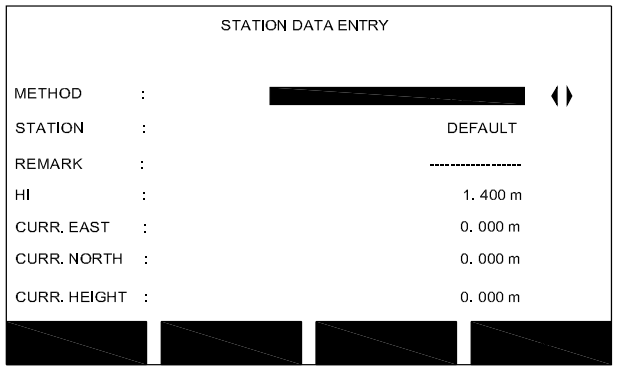
LEVELLING & CENTERING

Fig 3



LEVELLING & CENTERING

Fig 4



LEVELLING & CENTERING

Fig 5

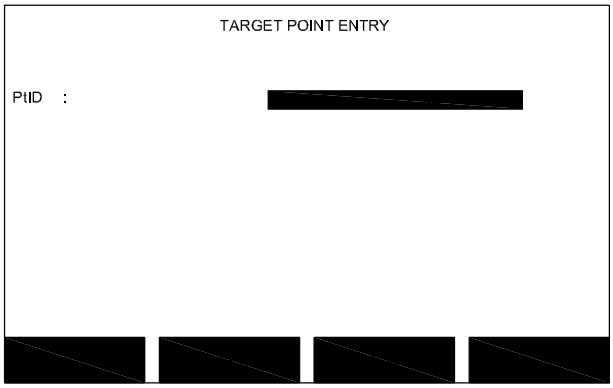


Fig 6

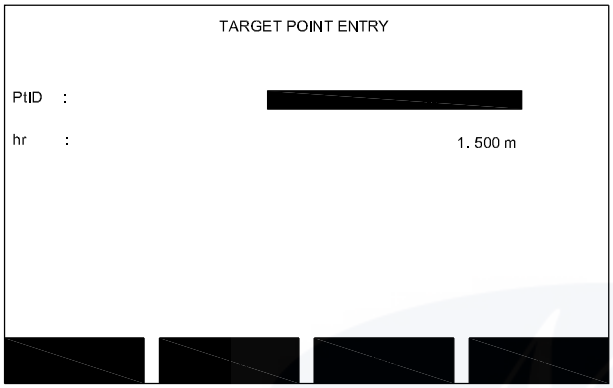
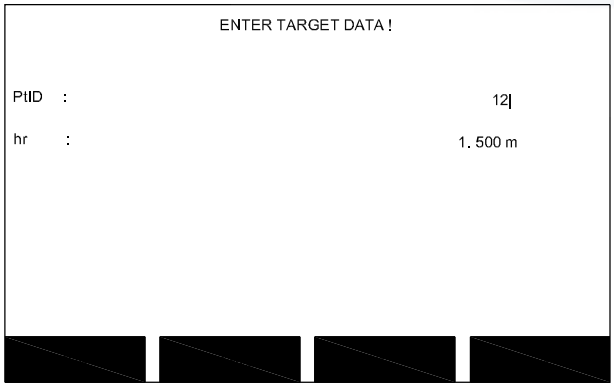


Fig 7



- Press F3 (OK).
- Press F4 (ENH)
- Enter the Easting, Northing and Elevation of the First point. (Fig 8)
- Press F4 (OK).
- Now slight this point and Press F3 (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

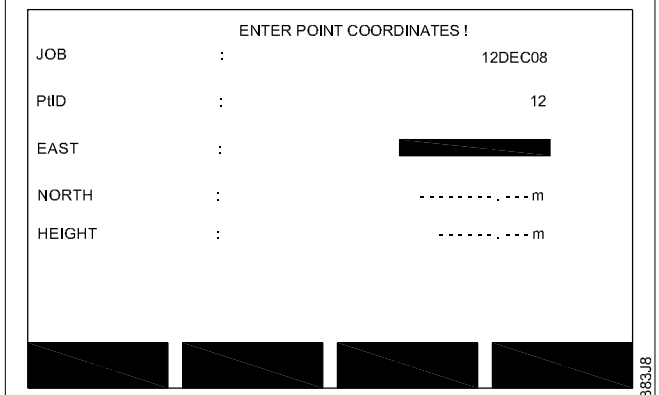


Fig 9

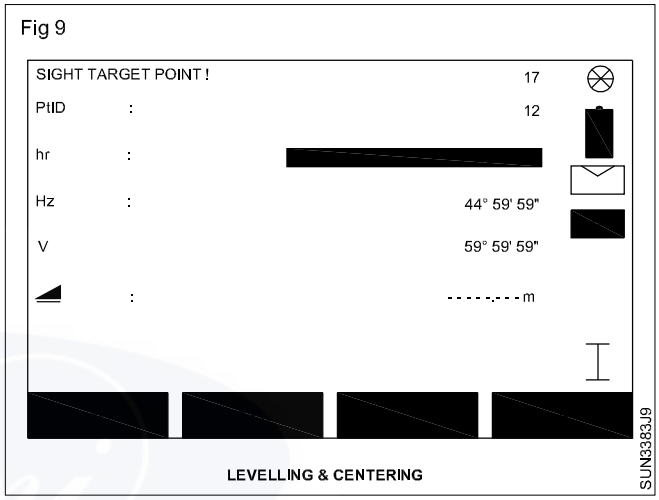
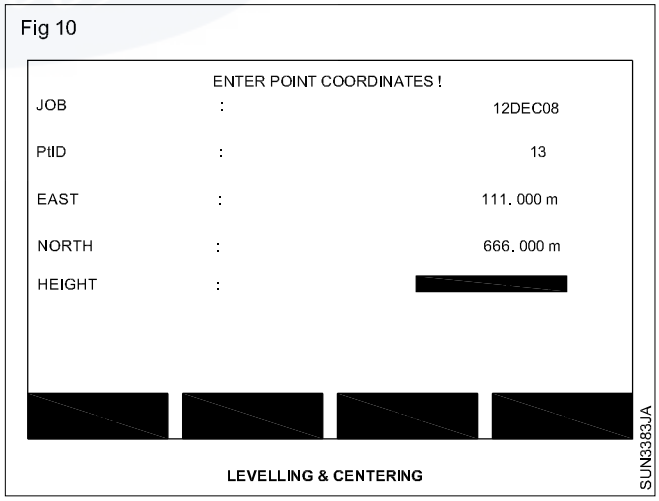


Fig 10



- Press F3 (OK)
- Press F4 (ENH)
- Enter the East, North and elevation of the next point.
- Press F4 (OK)
- Now Slight 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.**

PROCEDURE

Establish the total station. Do the centering and levelling. 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.
- Press F1 (Programs). (Fig 1)
- Press F4 (Reference element). (Fig 2)

Fig 1

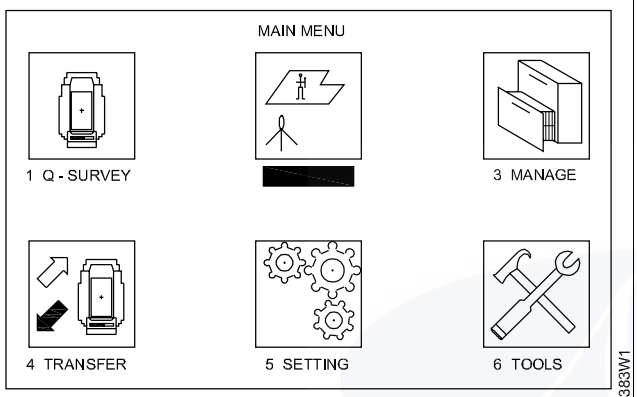
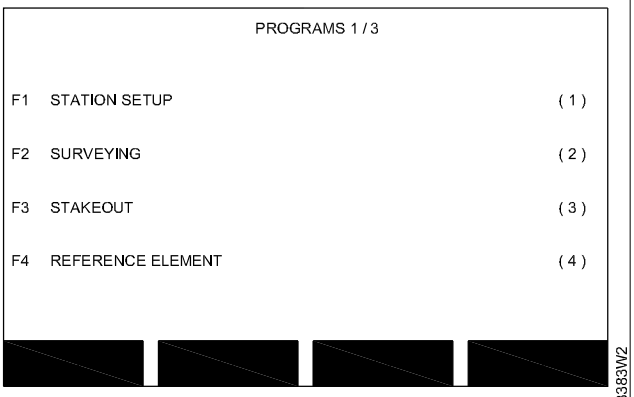


Fig 2



- Now set the station and orientation by use in the steps given already in station set up method program.
- Press F4 (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 F3 (ALL). (Fig 5)

Fig 3

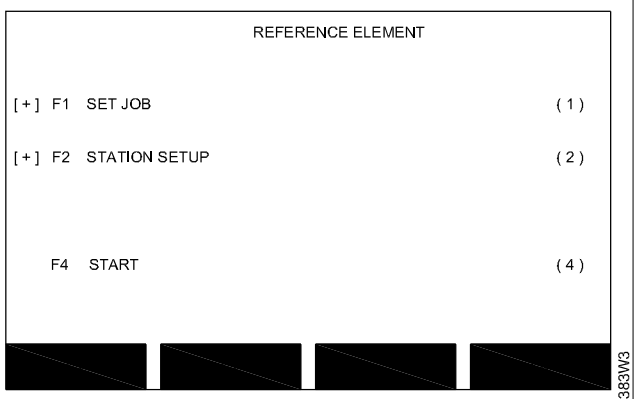


Fig 4

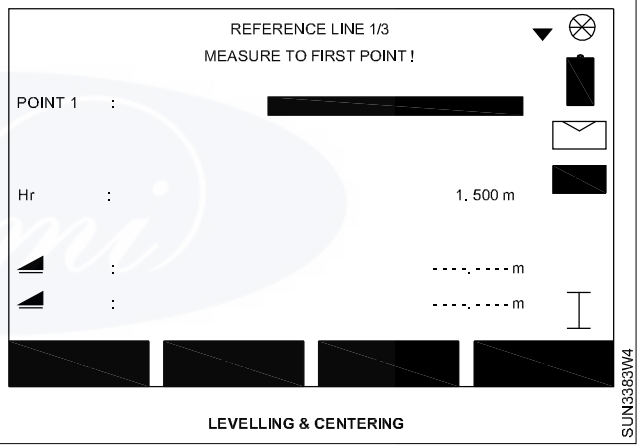
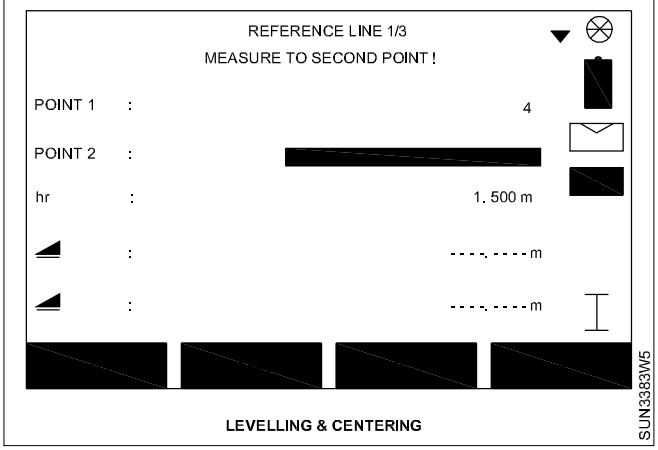


Fig 5



- Press F3 (StOUT). (Fig 6)
- Now enter the values of the offset and line with respect to the baseline first point. (Fig 7)
- Input center line distance in front of line. (Fig 8)

Fig 6

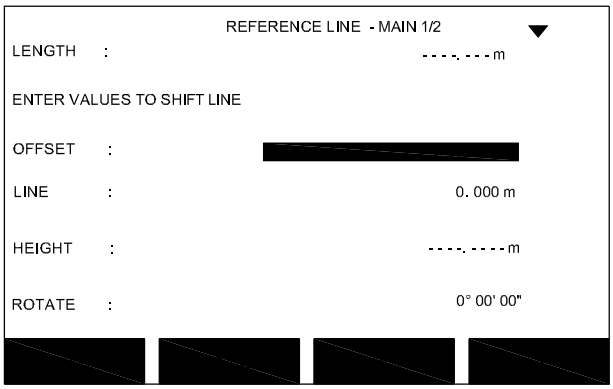


Fig 7

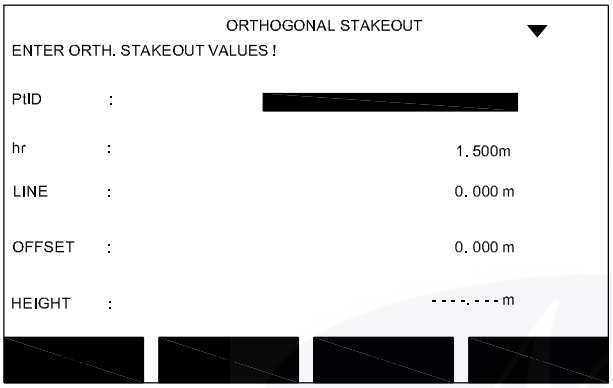
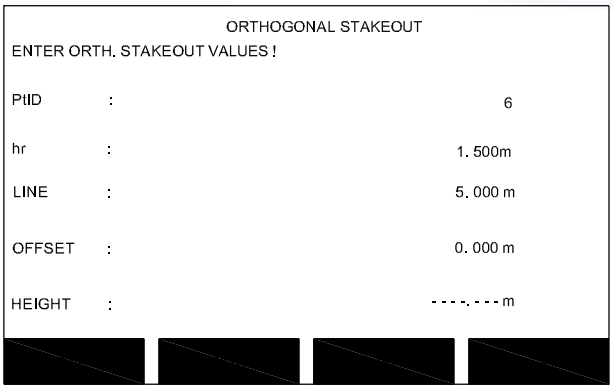


Fig 8



- Input Offset value If you want to input right side value then input 5.00 if you want to input left side value then input - 5.00 in front of offset. (Fig 9)
- Press F4 (OK). (Fig 10)
- Now the rest process is same as the stake out process.

Fig 9

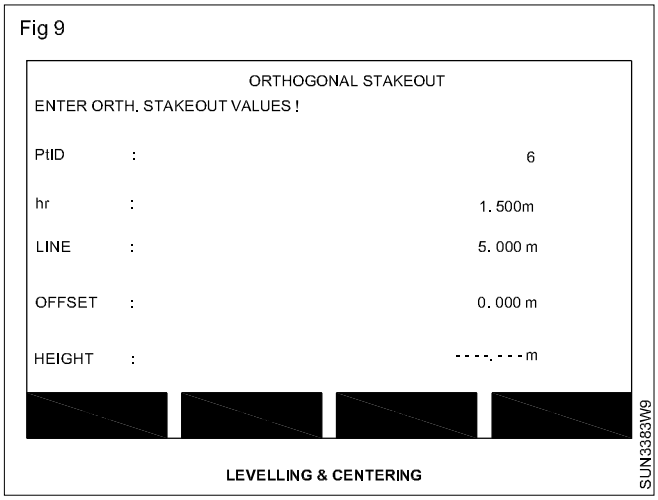
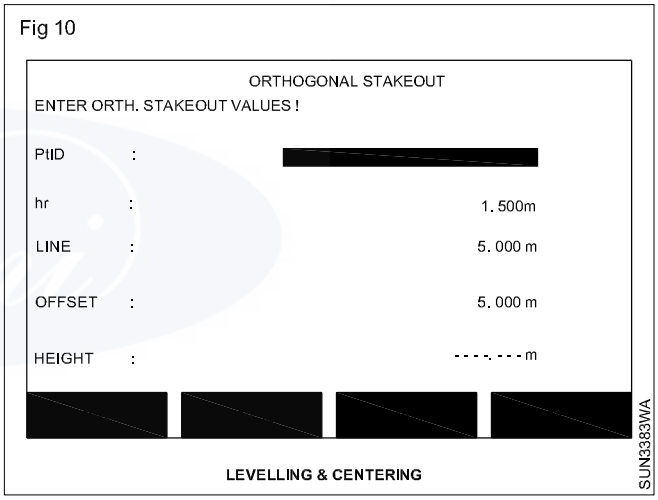


Fig 10



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.**

PROCEDURE

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 if 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)

Fig 1

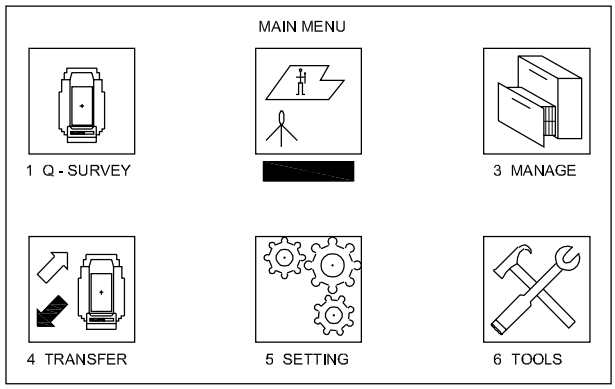


Fig 2

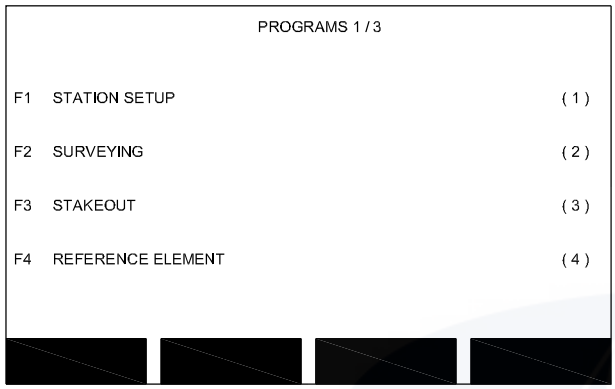
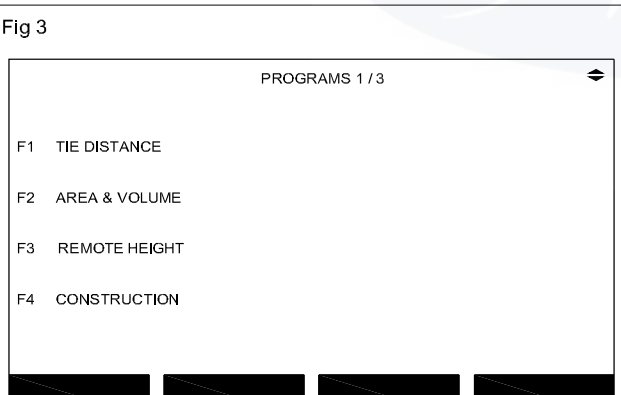


Fig 3



- Press F4 (Start). (Fig 4)
- There are two types, distance Polygonal and Radial.
- The polygonal 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)
- When the points are not in memory and you want to operate the program by taking the measurements right in the field.
- In front enter the number of the point and press F3 (ALL)

Fig 4

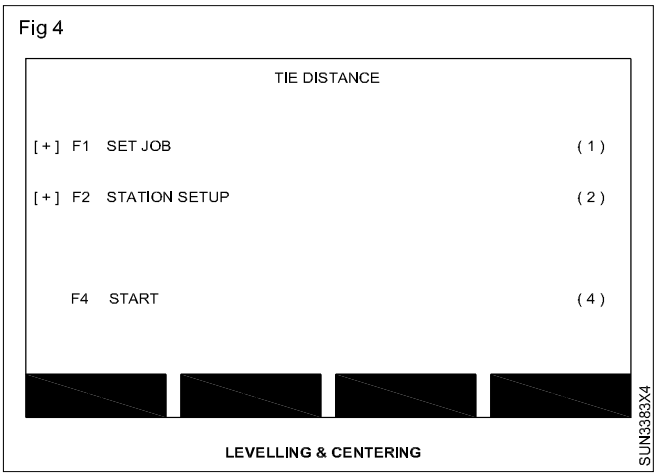


Fig 5

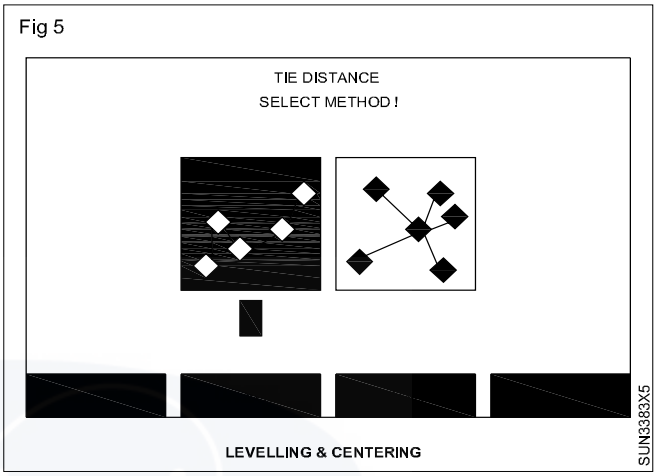
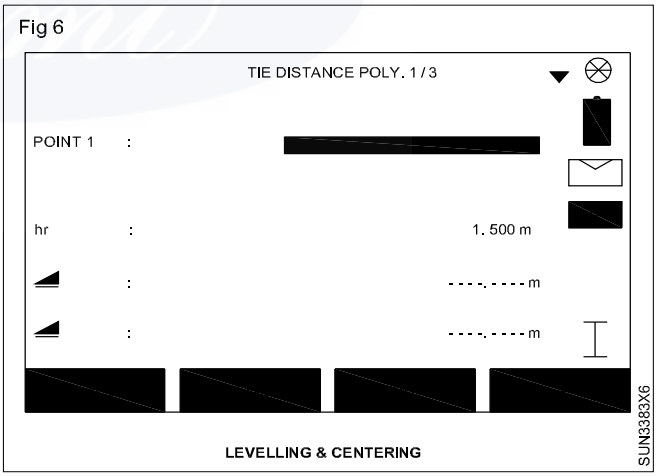
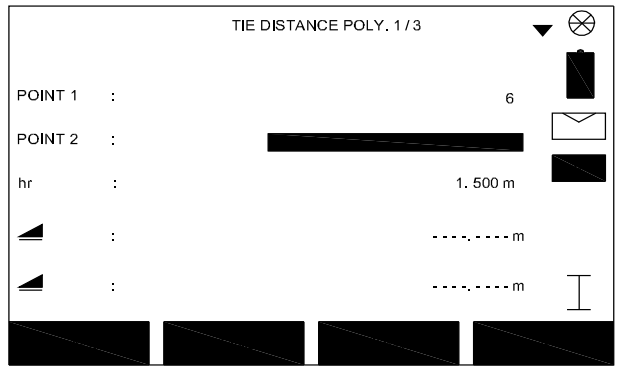


Fig 6



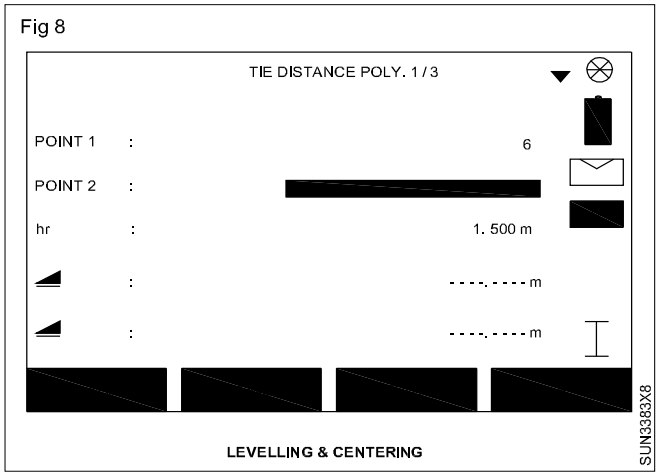
- In front of the Point 2 Enter the number of the Second point sight it and Press F3 (ALL). (Fig 7)
- Now you can see the results displayed on the screen. (Fig 8)
- When the coordinates of the points are already in the memory.
- In front of the point enter the number of the first point and press F2 (FIND)
- 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)

Fig 7



- Press F4 (OK)

Fig 8



- The results are displayed on the screen.

Area computation using total station

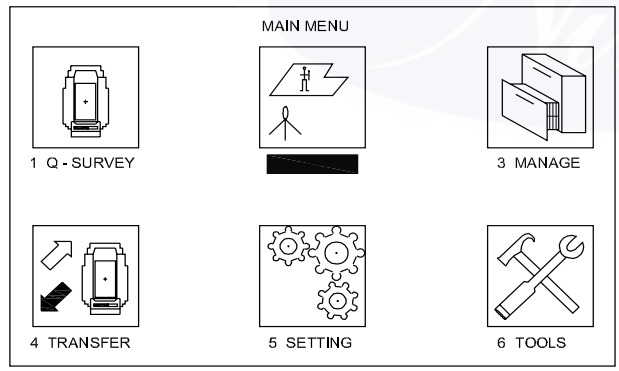
Objective: At the end of this exercise you shall be able to
- **compute the area of a plot in the field itself using a total station.**

PROCEDURE

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

- Press MENU.
- Press F1 (Programs).(Fig 1)

Fig 1



- Press PAGE. (Fig 2)
- Press F2 (Area). (Fig 3)
- The first three steps are the same.
- Press F4 (Start). (Fig 4)
- The points whose area is to the found can be either in the memory or can be slot directly in the field.
- In front of point ID Enter the number of the first point press F3 (ALL). (Fig 5)
- Keep on sighting the points in a proper sequence until you have all the points. Once you have shot all the points for the enclosing area, Press F2 (RESULTS). The results are displayed on the screen.

Fig 2

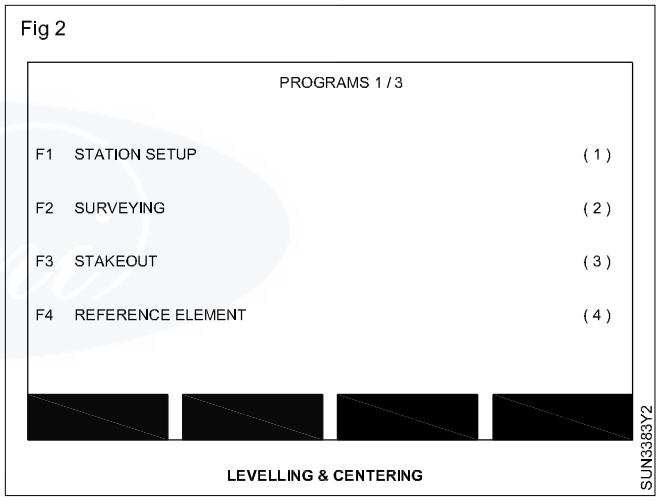
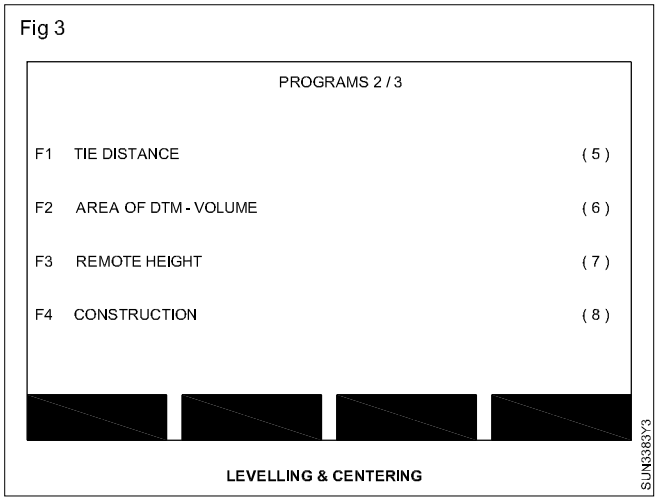


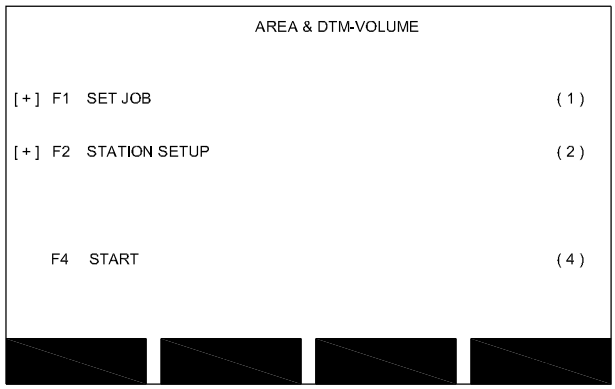
Fig 3



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

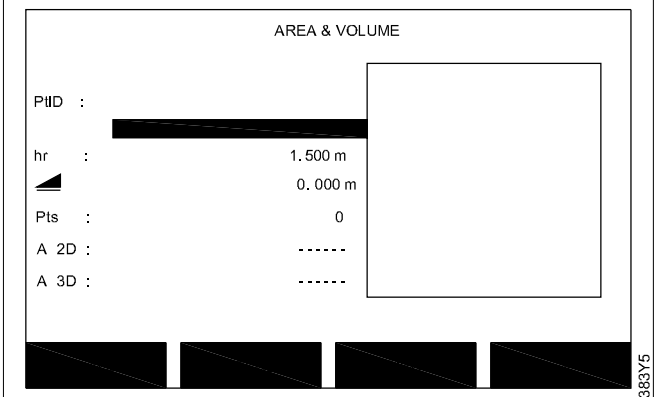
In front of the point ID enter the number of the point, which forms the enclosed area.

Fig 4



- After entering the point number, press FIND
- Press F4 (OK)

Fig 5



- Keep the repeating this procedure until you have all points imported in the point and press RESULT.
- The results will be displayed on the screen.

Computation of 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.**

PROCEDURE

Establish the Total Station. Do the centering and levelling. 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.
- Press F1 (Programs). (Fig 1)
- Press PAGE. (Fig 2)
- Press F3 (Remote Height). (Fig 3) & (Fig 4)
- Now put the prism on the base point and sight it and press F3 (ALL). (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

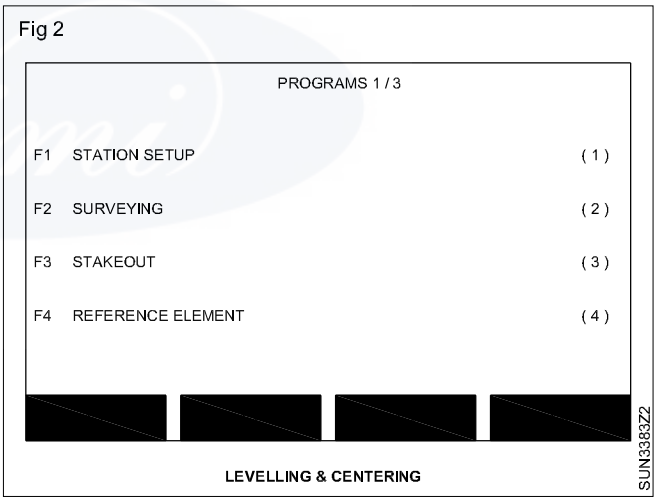


Fig 1

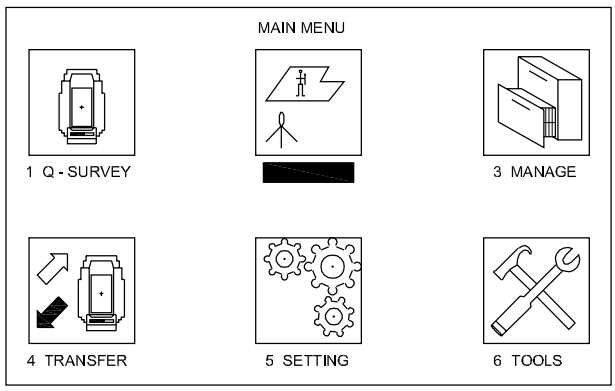


Fig 3

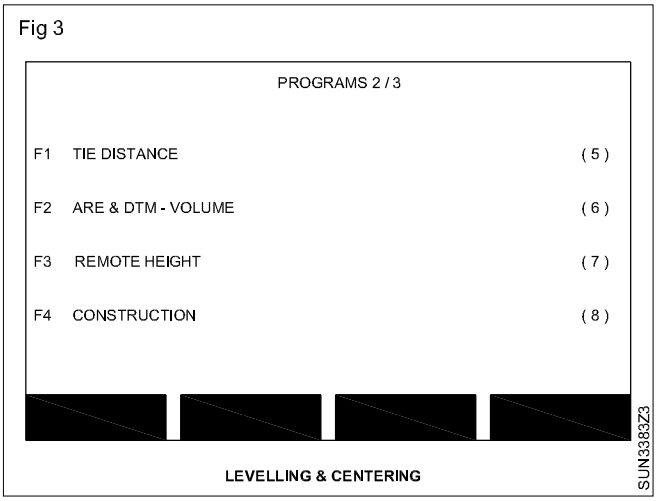
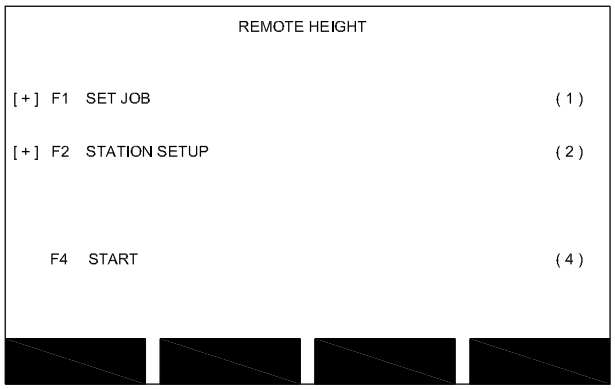
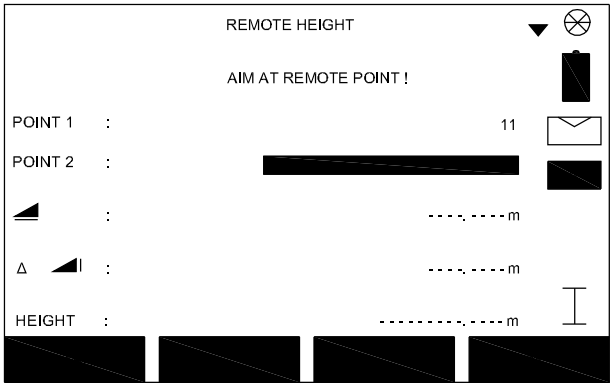


Fig 4



LEVELLING & CENTERING

Fig 5



LEVELLING & CENTERING

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

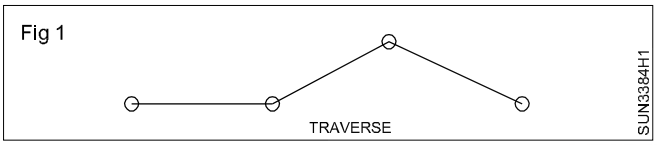
Materials

- Survey note 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)

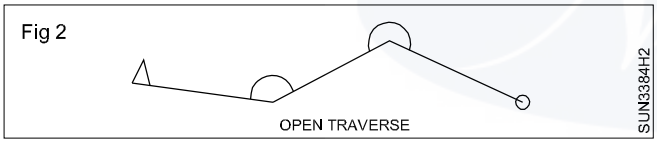
Fig 1



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)

Closed circuit traverse

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

Fig 3

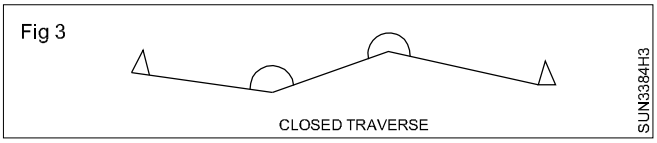
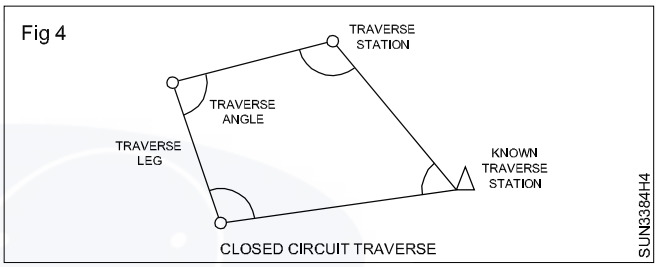


Fig 4



Grid bearing

Grid bearing of any survey line or traverse leg is the clockwise angle from grid north.

Magnetic bearing

Magnetic bearing of any survey line or traverse leg is the clockwise angle from magnetic north.

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.

Requirements

Tools/Equipments/Instruments

- Computer.

PROCEDURE

- Instructor should provide the required survey data for downloading.
- Explain how to download the data.
- Explain the procedure of plotting
- Check the trainees work at every stage.

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

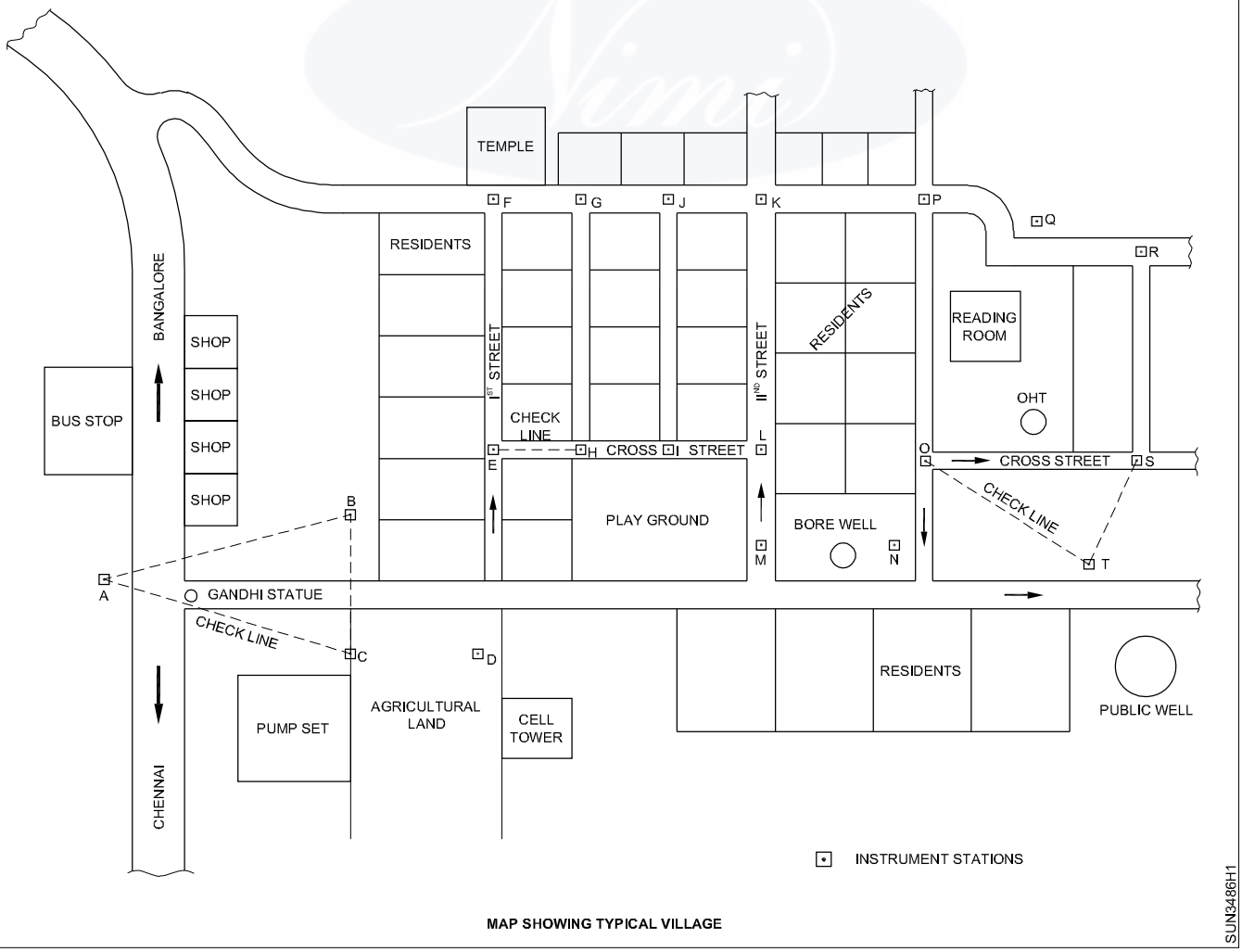
Materials

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

TASK 1: **Prepare a map of a village (Open traverse)**

- 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)
- Set up the table 'A' select the point a suitably on the sheet.

Fig 1



MAP SHOWING TYPICAL VILLAGE

- Centre and level the table when the board is clamped.
- Mark the direction of the magnetic north on the sheet.
- Place a ranging rod on station ‘B’.
- Keep the alidade on ‘a’ sight the ranging rod at ‘B’.
- Draw a ray along the bevelled edge of alidade.
- Measure the distance AB with tape.
- Select suitable scale and set off distance ‘ab’ already drawn.
- Locate the surrounding details by radiation or intersection.
- Shift the instrument and set it up at ‘B’
- Centre and level the table.
- Orient the table by back sighting on ‘A’
- Clamp the table.
- Place the ranging rod on station ‘C’.
- Keep the alidade pivoted on ‘b’ sight the station ‘C’.
- Draw a ray along the fiducial edge of the alidade.
- Measure the distance ‘BC’ with tape.
- Set off distance ‘bc’ on the ray.
- Locate the surrounding details by radiation or intersection.
- Proceed the same process until all the remaining stations and surrounding details are to be plotted.
- Prepare the map drawing using CAD software.

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

When no station is visible 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.

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

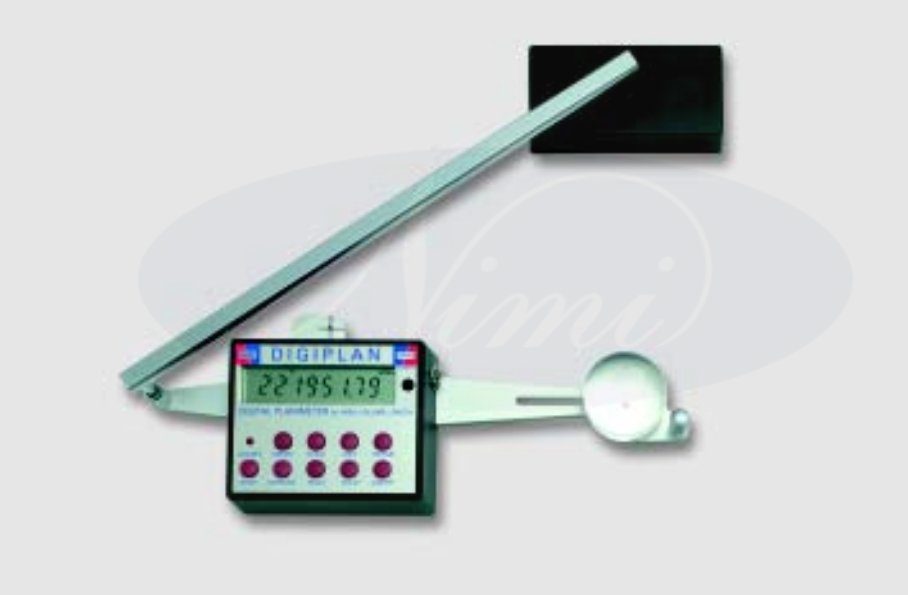
Materials

- Plot area drawing.

TASK 1: **Calculate the plot area by digital planimeter**

- Fix the drawing of given plot area.
- Kept the digital planimeter on the drawing sheet. (Fig 1)

Fig 1



DIGITAL PLANIMETER

- Kept the tracing arm which manages the position of tracing point at one end.
- Set the digital reading as zero at the initial level.
- Use anchor arm to manage the anchor position or needle point position on the plan.
- Fix the tracing arm in standard length without any extension.
- Move the tracing needle carefully over the out line of the given plan till the first point is reached.
- Move the tracing needle in clockwise direction.
- note down the reading at the first point and then the final point reading.
- Final reading will indicate the area of given plot area.

Road Project : Reconnaissance Survey

Objectives: At the end of this exercise you shall be able to
- **conduct map study**
- **conduct reconnaissance survey.**

Requirements

Tools / Instruments

- Prismatic compass with tripod
- Plane table with all accessories
- Levels with levelling staff
- Theodolites
- Tapes

Materials

- Drawing sheets
- Pencils
- Eraser.

TASK 1 : **Map study**

1 Mark the various possible routes on the map connecting the terminal points observing the criteria of route selection.

2 Study well various routes by conducting reconnaissance survey.

— — — — — — — —

TASK 2 : **Reconnaissance survey**

1 Measure the magnetic bearing of the lines of the alignment by a prismatic compass and note in the field book.

2 Measure the distances along the alignment approximately by pacing.

3 Note the objects and nature of the ground on both sides of the alignment up to 50 m on the field book.

4 Avoid obstacles like religions places or valuable structure if any while fixing alignment.

5 Avoid crossing the alignment obliquely over the river by diverting the alignment suitably.

6 Note all other important points like the railway crossing, canal crossing, etc.

7 Collect the HFL (High Flood Level) ever attained and the discharge records for the last few yeas from the appropriate authorities to design the culverts and bridges.

8 Prepare preliminary records of properties eligible for compensation.

— — — — — — — —

Road Project :Preliminary Survey

Objective: At the end of this exercise you shall be able to
• conduct preliminary survey.

Requirements

Tools / Instruments

- Prismatic compass with tripod
- Plane table with all accessories
- Levels with levelling staff
- Theodolites
- Tapes

Materials

- Drawing sheets
- Pencils
- Eraser.

TASK 1: **Preliminary survey**

1 After fixing suitable alignment construct a pillar at the staring point of the alignment of the road which is already fixed by reconnaissance survey.

2 Consider by fly level to connect the near by GTS bench mark with the starting point of the road project.

3 Conduct a prismatic compass survey or plane table survey to prepare route survey map covering about 50M on both sides of the alignment.

4 Conduct a longitudinal map levelling along the alignment at regular interval (say 20 or 40 m).

5 Take cross sections at regular intervals (say 100 m)

6 Establish permanent bench marks at suitable places along the alignment for future reference.

7 Take cross sections of the rivers, etc accurately.

8 Prepare the following drawings :

a Route survey map

b Longitudinal map section with formation levels

c Cross sections with formation width and side slope

d Contour map of the strip of land along alignment

e Design of curves with setting out tables.

F Mass diagram for the earthwork.

— — — — — — — —

Road Project : Location Survey

Objectives: At the end of this exercise you shall be able to
• conduct location survey
• preparing construction survey.

Requirements

Tools / Instruments

- Prismatic compass with tripod
- Plane table with all accessories
- Levels with levelling staff
- Theodolites
- Tapes

Materials

- Drawing sheets
- Pencils
- Eraser.

TASK 1 : **Location survey**

1 Fix the centre line of the road after selecting the most economical alignment by set out pegs or pillars at intervals of 30m.

2 Mark the total land width required by pillars at regulars intervals (say 30 m)

3 Mark tangent points and intersection points of the curves by pillars.

— — — — — — — —

TASK 2 : **Construction survey**

1 After location survey retrace the centre line shown on the plan and referencing centering points on the curve.

2 Check bench marks, running centre line levels over the retraced lines.

3 Take elevations at all stations, at all breaks on the ground and at other points where it is necessary to take cross section for volume.

4 Set slope stakes and grade stakes.

5 Set stakes for complete layout of culverts and bridges.

6 Set out curves.

7 Report and make advantageous changes, if any in line grade or minor adjustment of the drainage structure.

8 Reset the stakes that have been destroyed as the progresses.

— — — — — — — —

Profile of longitudinal of levelling and plotting

Objective : At the end of this exercise you shall be able to
• determine the reduced levels of points at known distances along the given routs.

Requirements

Tools/Equipments/Instruments

- Dumpy level with tripod
- Telescopic levelling staff
- Pegs, hammer
- Set Squares, T- Square, Scale set

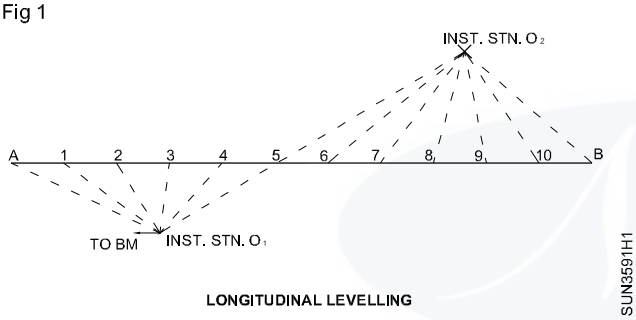
Materials

- Levelling field book, pencil, eraser
- Drawing sheet - A2 size
- Colour pencil / pen- 1 set.

PROCEDURE

1 Mark the end points of the centre line AB with ranging rods. (Fig 1)

Fig 1



2 Measure the direction of the line using prismatic compass.

3 Measure the length of the line AB using tape and erect pegs at an interval of 200 m along the line AB. Also erect pegs at the points where the ground level changes abruptly.

4 Set up and level the instrument at a suitable point '0_1' from where maximum number of observations is possible.

5 Take a BS reading on the bench mark and intermediate sights on the longitudinal section points.

6 Also take a foresight reading on a suitable change point on account of the length of sight being beyond the power of the telescope.

7 Shift the instrument to a suitable position and carry out the temporary adjustments.

8 Take a BS reading on the change point and continue the process until the last point is reached.

9 Record the readings in the respective columns as soon as they are taken, in the following tabular form.

10 Calculate the reduced levels of the points by height of instrument method.

Note : Work should always commence from a bench mark and should end on a bench mark.

Station	Chainage	Bearing		BS	IS	FS	HI	RL	Remarks
		FB	BB						

Plotting of longitudinal section

Objective : At the end of this exercise you shall be able to
- **prepare the longitudinal section of the route.**

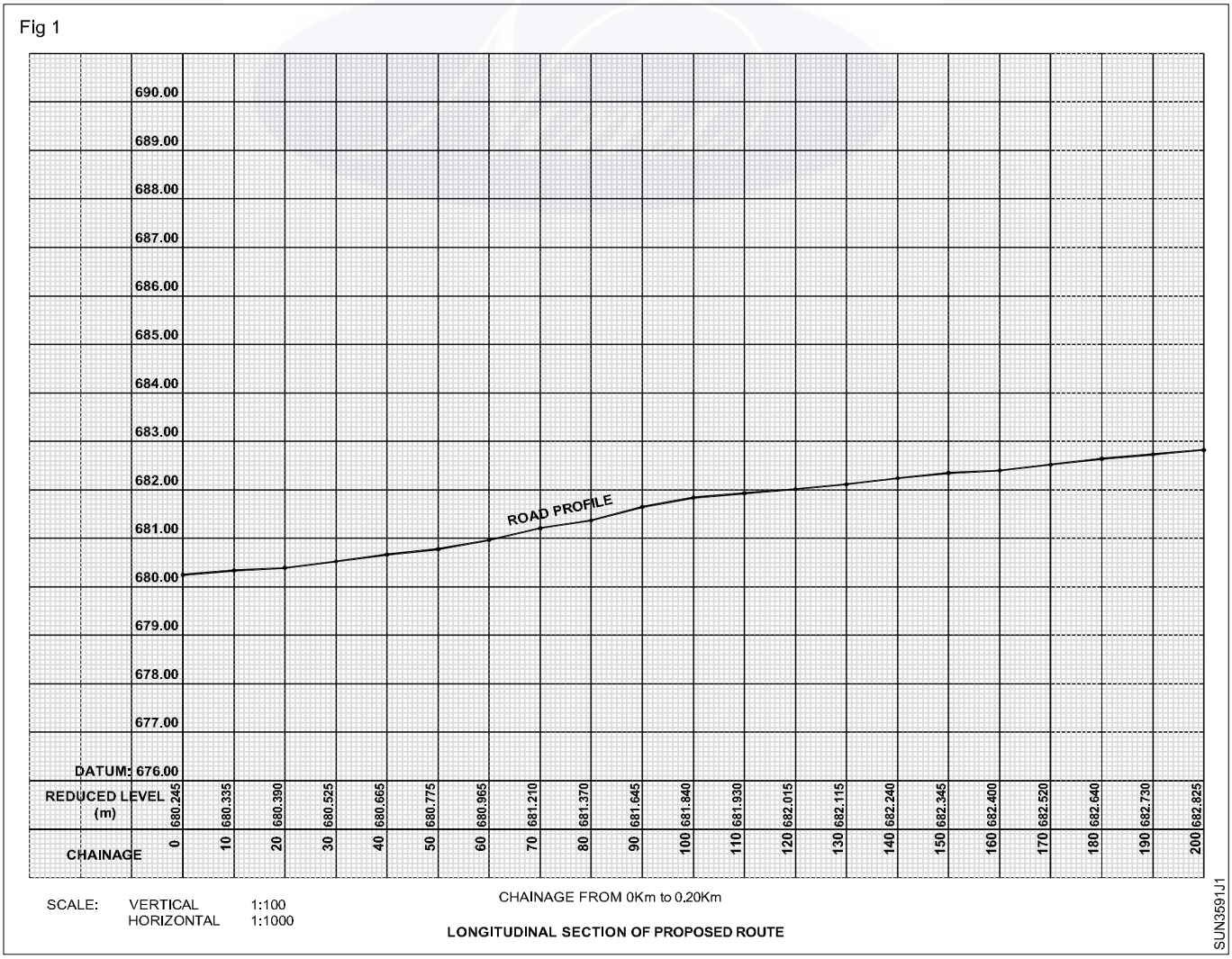
PROCEDURE

1 Read and interpret the chainages and levels of the route.

Chainage	Ground level
0	680.245
1	680.335
20	680.395
30	680.525
40	680.665
50	680.775
60	680.965
70	681.210
80	681.370
90	681.645
100	681.840
110	681.930
120	682.015
130	682.115
140	682.240
150	682.345
160	682.400
170	682.520
180	682.640
190	682.730
200	682.825

2 Select a suitable horizontal scale (1:1000) and a vertical scale (1:100) (Fig 1)

Fig 1



3 Draw a horizontal line of length 20cm, equal to the length of the section line.

4 Mark the longitudinal section points on this line and also note the chainages of these points.

5 Note the reduced levels of the ground points against the respective chainage points.

6 Draw another horizontal line parallel and equal to the first, keeping a vertical distance of 2 cm, representing the datum line.

7 Choose a suitable datum level 676.000

(Datum level should be selected in such a way that the length of the ordinate should be between 4 cm to 15 cm)

8 Mark the longitudinal section points on the datum line.

9 Draw vertical lines through these points.

10 Scale off the ground level and mark the ground levels on the respective lines.

11 Join these points by straight lines to get the outline of the ground surface.

Note : The datum line and ground line are drawn in black and the perpendicular lines in thin blue lines.

Cross sectioning

Objective : At the end of this exercise you shall be able to
- **determine the reduced levels of points along the transverse direction.**

PROCEDURE

1 Mark the end point of the centre line AB with ranging rods.

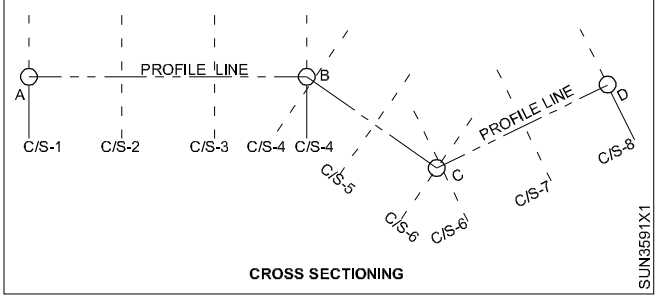
2 Measure the direction of the line using prismatic compass.

3 Measure the length of the line AB using tape and erect pegs at an interval of 200m long the line AB. Also erect pegs at the points where the ground level changes abruptly.

4 Erect cross section lines at right angles to the longitudinal section line at an interval of 20 m along the centre line.

5 Mark cross section points at an interval of 5m from the centre point on either side of the cross section line.

Fig 1



CROSS SECTIONING

6 Set up and level the instrument at a suitable point '0' from where maximum number of observations is possible.

7 Take a back sight readings on the bench mark.

8 Also take staff reading at '0' chainage and on the cross section points on either side of the centre line.

9 The staff reading on the cross section points and their distance from the centre line are entered in the level book accordingly as they are on the right or left of the centre line.

10 Take a foresight reading on a change point on account of the length of sight being beyond the power of the telescope.

11 Shift the instrument to a suitable position and carry out the temporary adjustments.

12 Resume the work from the change point and continue the process untill the last point is reached.

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

Note: Work should always commence from a bench mark and should end on a bench mark.

Observations taken on longitudinal section points and observations taken on each cross section line should be recorded separately.

Tabular form - Longitudinal section.

Station	Chainage	BS	IS	FS	HI	RL	Remarks

Cross - Section at chainage 'O'.

Station	Distance			BS	IS	FS	HI	RL	Remarks
	L	C	R						

Plotting of cross section

Objective : At the end of this exercise you shall be able to
- **plot the cross section on a drawing sheet.**

PROCEDURE

1 Read and interpret the given levels.

Cross section at “0m” chainage.

Distance		Reduced level
Left	Right	
0		680.245
0.75		680.235
1.75		680.215
2.75		680.165
3.0		680.145
3.5		680.145
4.0		680.135
5.0		680.150
	0.75	680.255
	1.75	680.295
	2.75	680.295
	3.0	680.305
	3.5	680.320
	4.0	680.325
	5.0	680.385

Cross section at “50m” chainage

Distance		Reduced level
Left	Right	
50		680.775
0.75		68.760
1.75		680.740
2.75		680.740
3.0		680.660
3.5		680.630
4.0		680.645
5.0		680.395
	0.75	680.785
	1.75	680.785
	2.75	680.730
	3.0	680.770
	3.5	680.795
	4.0	680.815
	5.0	680.875

Cross section at “100m” chainage

Distance		
Left	Right	Reduced level
100		681.840
0.75		681.855
1.75		681.870
2.75		681.870
3.0		681.885
3.5		681.850
4.0		681.850
5.0		681.745
	0.75	681.760
	1.75	681.705
	2.75	681.665
	3.0	681.665
	3.5	681.685
	4.0	681.715
	5.0	681.735

Cross section at “150m” chainage

Distance		
Left	Right	Reduced level
150		682.345
0.75		682.335
1.75		682.325
2.75		682.310
3.0		682.645
3.5		682.385
4.0		682.515
5.0		682.590
	0.75	682.330
	1.75	682.320
	2.75	682.300
	3.0	683.355
	3.5	682.385
	4.0	682.485
	5.0	682.535

Cross Section at “200m” chainage

Distance		
Left	Right	Reduced level
200		682.825
0.75		682.820
1.75		682.865
2.75		682.905
3.0		682.935
4.0		683.095
5.0		683.195
	0.75	682.800
	1.75	682.800
	2.75	682.805
	3.0	682.885
	3.5	682.915
	4.0	682.950
	5.0	682.775

2 Select a suitable horizontal scale (1:100) and a vertical scale (1:100).

3 Draw a horizontal line of length 10 cm, equal to the length of the section line.

4 Mark the cross section points on this line and also write the distance of these points from centre point.

5 Note also the ground levels of these points.

6 Draw another horizontal line representing the datum line, keeping a vertical distance of 2 cm.

7 Choose a suitable datum level 678.000.

8 Mark section points on the datum line.

9 Draw vertical lines through these cross section points.

10 Scale off the ground level and ground points on the respective vertical lines.

11 Join these points by straight lines to get the ground surface along the tranverse direction.

12 Similarly draw other cross sections. Datum level need not be constant for all cross sections.

Read and interpret the given levels of a road profile for cross section

C/S at L.S 0m chainage datum: 678.000

0m	680.245m		
L 0.75	680.235	R 0.75	680.255
L 1.75	680.215	R 1.75	680.295
L 2.75	680.165	R 2.75	680.295
L 3.00	680.145	R 3.00	680.305
L 3.5	680.145	R 3.5	680.320
L 4.0	680.135	R 4.0	680.325
L 5.0	680.150	R 5.0	680.385

C/S at L.S 50m chainage datum: 678.000

50m	680.775m		
L 0.75	680.760	R 0.75	680.785
L 1.75	680.740	R 1.75	680.780
L 2.75	680.670	R 2.75	680.730
L 3.00	680.660	R 3.00	680.770
L 3.5	680.630	R 3.5	680.795
L 4.0	680.645	R 4.0	680.815
L 5.0	680.395	R 5.0	680.875

C/S at L.S 100m chainage datum: 679.000

100m	681.840m		
L 0.75	681.855	R 0.75	681.760
L 1.75	681.870	R 1.75	681.705
L 2.75	681.870	R 2.75	681.665
L 3.00	681.885	R 3.00	681.655
L 3.50	681.850	R 3.50	681.685
L 4.0	681.830	R 4.00	681.715
L 5.0	681.745	R 5.00	681.735

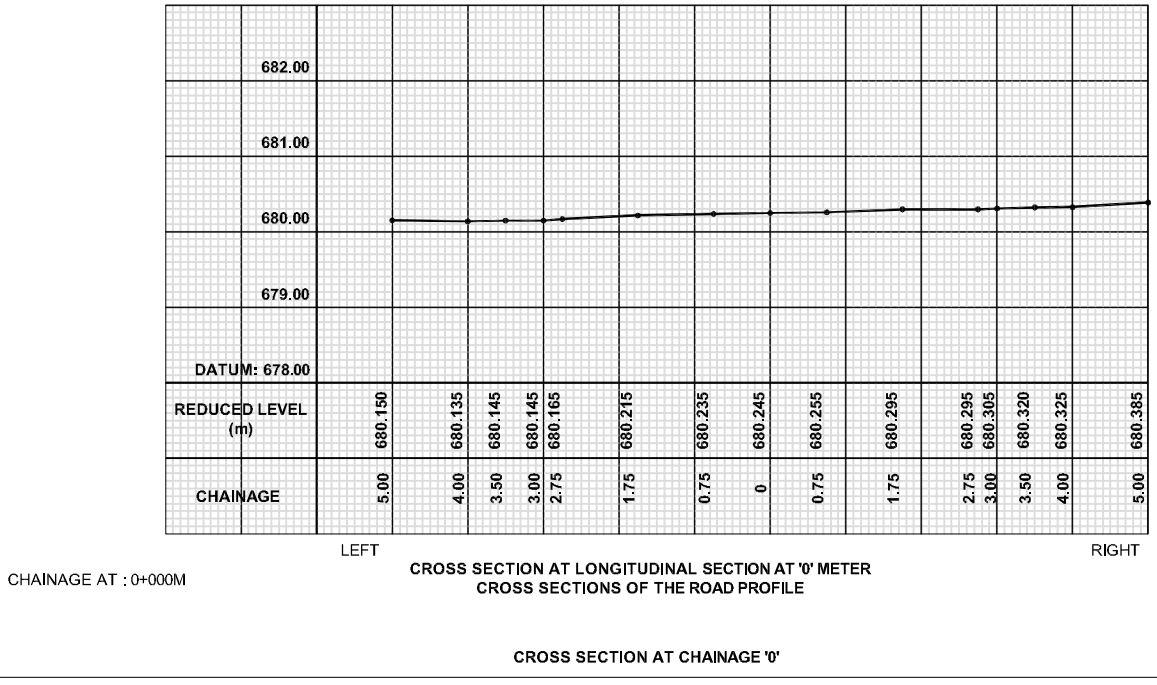
C/S at L.S 150m chainage datum: 681.000

150m	682.345m		
L 0.75	682.335	R 0.75	682.330
L 1.75	682.325	R 1.75	682.320
L 2.75	682.310	R 2.75	682.300
L 3.00	682.345	R 3.00	682.355
L 3.50	682.385	R 3.50	682.385
L 4.0	682.515	R 4.00	682.485
L 5.0	682.590	R 5.00	682.535

C/S at L.S 200m chainage datum: 681.000

200m	682.825m		
L 0.75	682.820	R 0.75	682.800
L 1.75	682.865	R 1.75	682.800
L 2.75	682.905	R 2.75	682.805
L 3.00	682.935	R 3.00	682.885
L 3.50	683.005	R 3.50	682.915
L 4.00	683.095	R 4.00	682.950
L 5.00	683.195	R 5.00	682.775

Fig 1



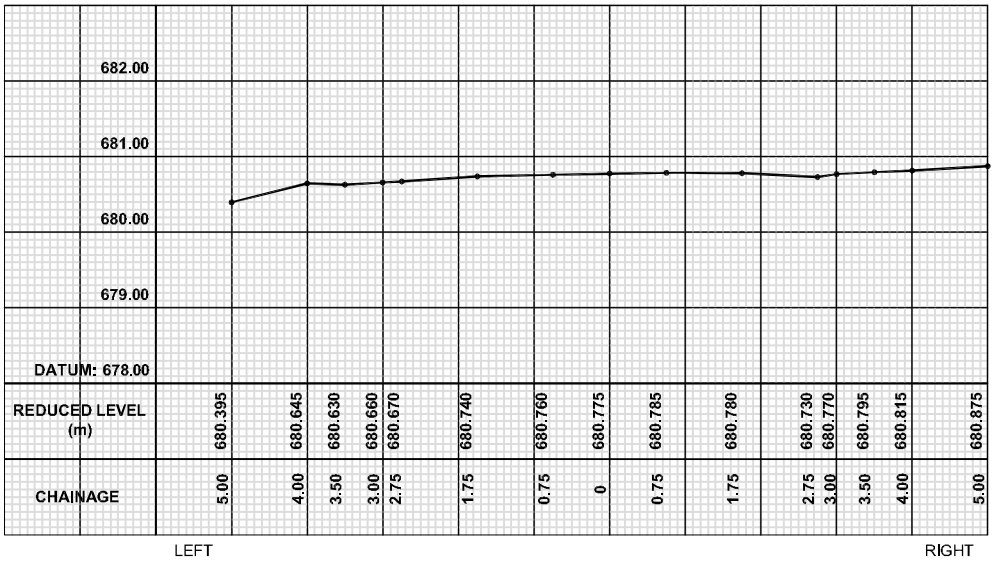
CHAINAGE AT : 0+000M

CROSS SECTION AT LONGITUDINAL SECTION AT '0' METER
CROSS SECTIONS OF THE ROAD PROFILE

CROSS SECTION AT CHAINAGE '0'

SUN3591Y1

Fig 2

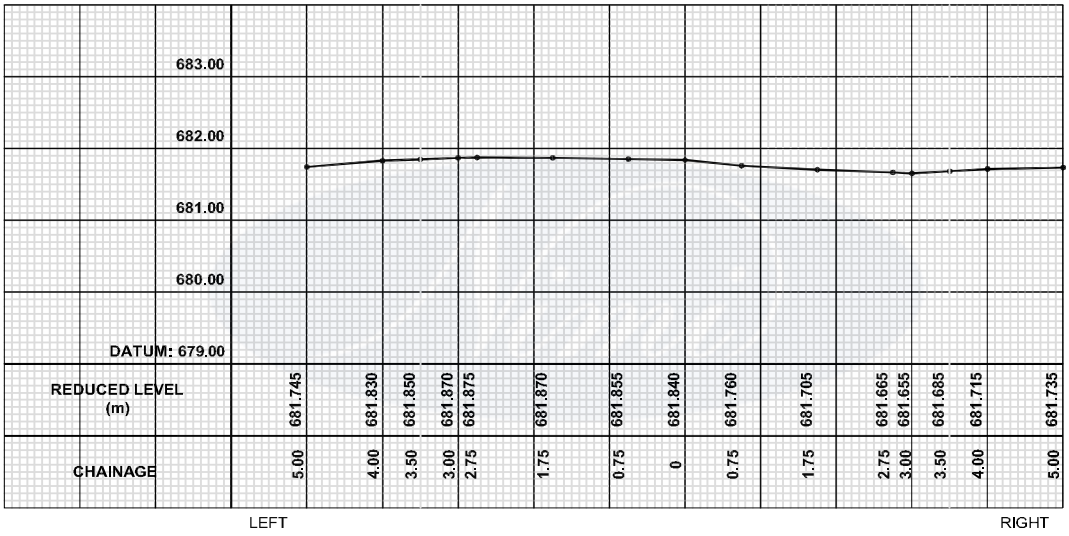


CHAINAGE AT : 0+050M

CROSS SECTION AT CHAINAGE 50M

SUN3591Y2

Fig 3

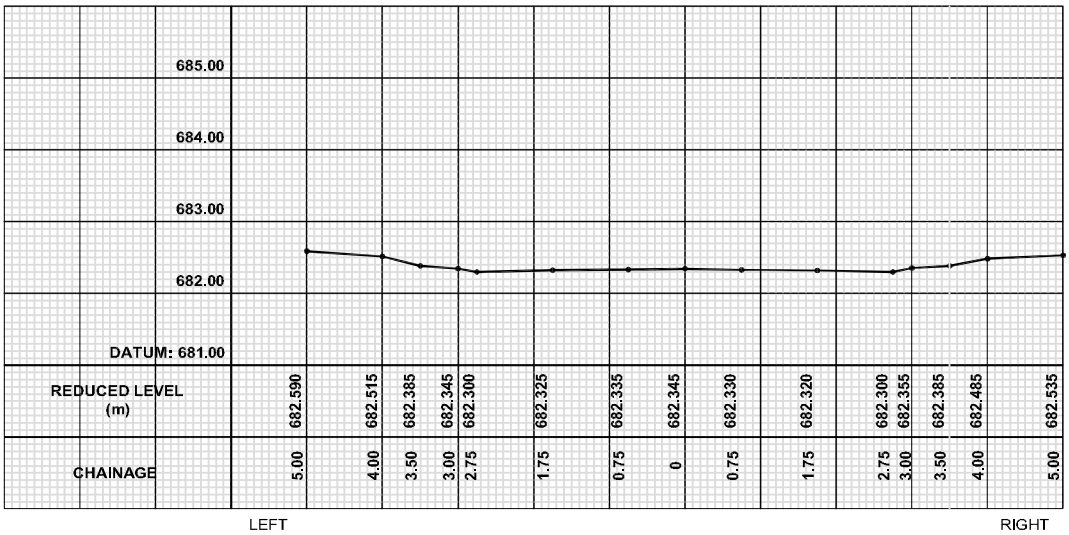


CHAINAGE AT : 0+100M

CROSS SECTIONS AT CHAINAGE 100

SUN3591Y3

Fig 4

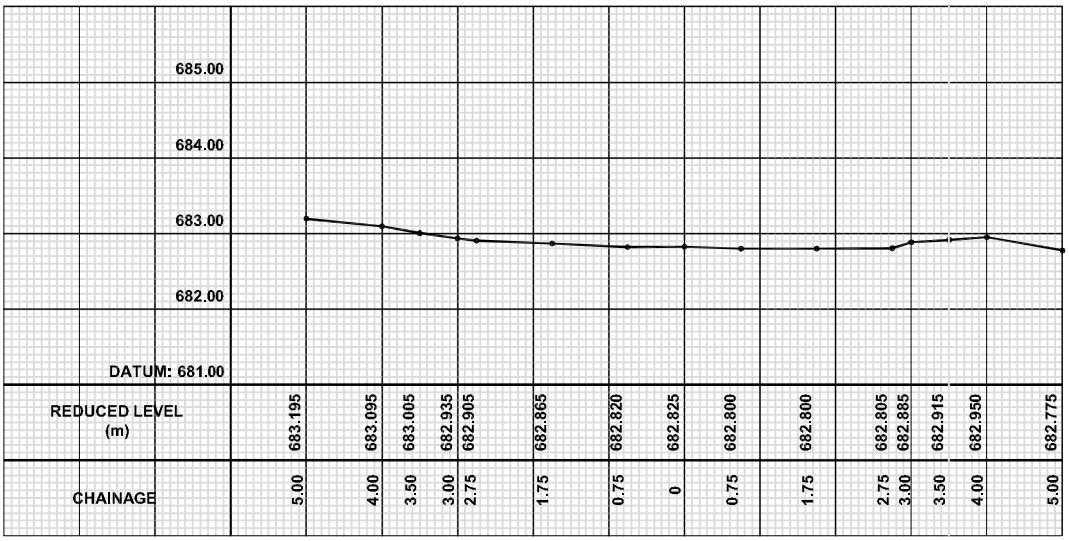


CHAINAGE AT : 0+150M

CROSS SECTIONS AT CHAINAGE 150M

SUN3591Y4

Fig 5



CHAINAGE AT : 0+200M

SCALE: VERTICAL 1:100
HORIZONTAL 1:1000

CROSS SECTION AT CHAINAGE 200M

SUN3591Y5

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.

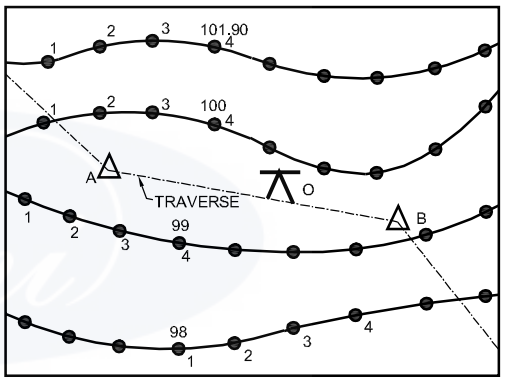
TASK 1 : **Preparation of topographical map by direct method (vertical control) (Fig 1)**

- Select uniform from fairly slope ground.
- Select fairly equal level of point
- Set the levelling instrument at the station ‘O’
- Take the staff reading at BM
- Read the height of instrument 101.90m.
- Take the staff reading spot levels which is less than the 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.

- Take spot levels 1,2,3,4 is 98.00m.
- Take spot levels at 1,2,3,4 is similarly at 99.00m, 100.00m.
- Contour lines as already sported in field work.
- The spot levels reading must be in respective contour levels.
- While taking reading the levels are differ more than

Fig 1



VERTICAL METHOD

limit ask the staff man shift the staff at suitable spot.

- Change the instrument at a station point ‘P’ by traverse.
- Take the levels according to the contour line levels.
- Plot the contour lines of the area with field work of level readings.
- Contour lines indicate, the topographical of the area.

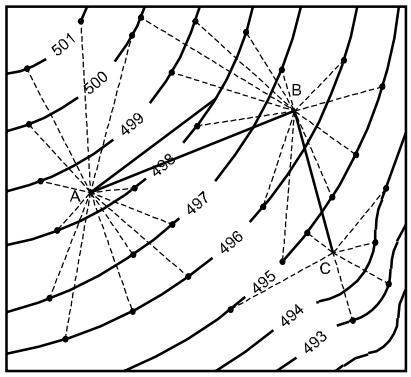
— — — — — — — —

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

- Locate the contour points roughly same horizontal line (5 to 6 points)
- Locate another 5 to 6 points roughly in 100.300m level
- Locate the points 100.500m, 100.150, 101.00m.
- Indicate the identification of each points in each level.
- Use arrows, and the arrows has paper tag with point identification
- Set the plane table at station ‘A’ and view more area of contour level.
- Draw the rays by radiation method above said 5 or 6 points.
- Measure the distance of the points from the plane table station.
- Shift the plane table at ‘B’ station, back sight in the old station ‘A’
- Set up the plane table.

- Measure the distance in between the station A and B.
- Higher level points sighted with telescopic alidade.
- A and B stations are not sufficient to cover contour points, proceed a traverse method and find out the points.
- Complete the field in drawing sheet.

Fig 2



SURVEYING LOCATIONS OF CONTOURS

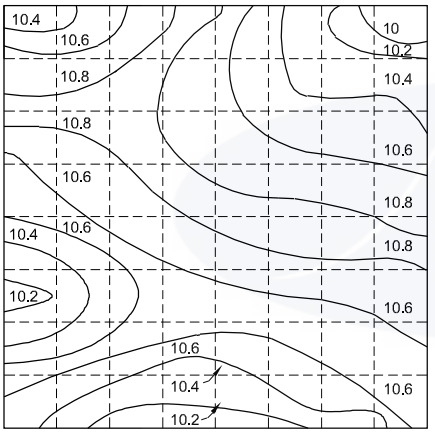
SUN3592H2

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



SUN3592J1

- Select the area should be small and the ground is not very undulating.

  Divide the area into number of squares.
- Divide the square vary from 3 to 5m.
- Determine the elevation of the corner of square by a level and staff.
- Small square enough to conform to the inequalities of the ground and to the accuracy required.
- Enter the staff reading in level filed book.
- Draw contour lines by interpolation of same level.

Make a cadestral/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

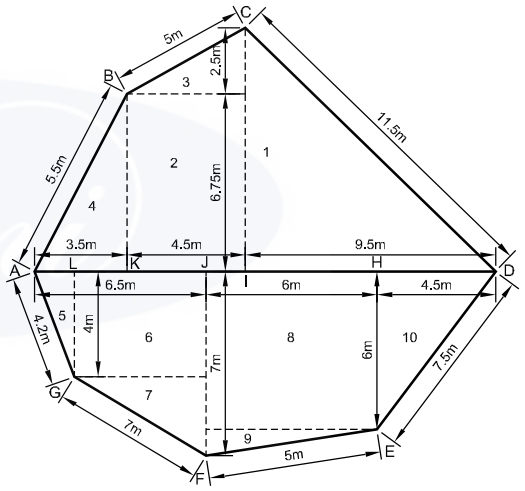
Materials

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

TASK 1

- Mark the stations A and D, 17m. (Fig 1)
- Fix the ranging rod A and D
- Check the perpendicular by cross staff at H.
- Mark the distance 6m at E
- Join DE
- Mark the distance I, 9m from D and erect perpendicular at a distance of 9.25m and mark c.
- Join DC
- Similarly join the point CB, BA, AG, GF, FE and ED
- Join all points by straight line.
- Complete the work.

Fig 1



TASK 2

Calculate the plot area

Part 1:

Area of right angled triangle : ½ x base x height

= ½ x 9.5 x 9.25m^2

= 43.94m^2

Part 2:

Area of rectangle = l x b

= 6 x 6

= 36m^2

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

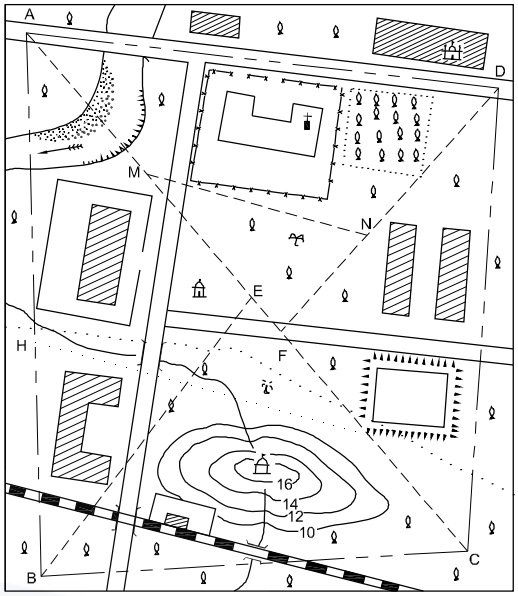
Cadastral survey (various obstracal)

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)**

- Select an area (e.g) your I.T.I (building) total area land.
- Select 4 to 6 main chain stations. Each station should be visible.
- Select number of tie station/subsidiary station points in main chain line, to locate details of place/land.
- Proceed a chain line diagonally to the main station (or) may join near main chain line
- Proceed the chain line from station one to other station.
- 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.
- The cadastral survey may done with 4 (or) 5 team having the chain survey tools & equipments.
- Conduct the survey each team from different main station point to other main station point.
- Assemble the team chain survey details and plot the total area detail in class room/ drawing room.
- Finally the map (survey map) may be of fig1 shown below.

Fig 1



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

Materials

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

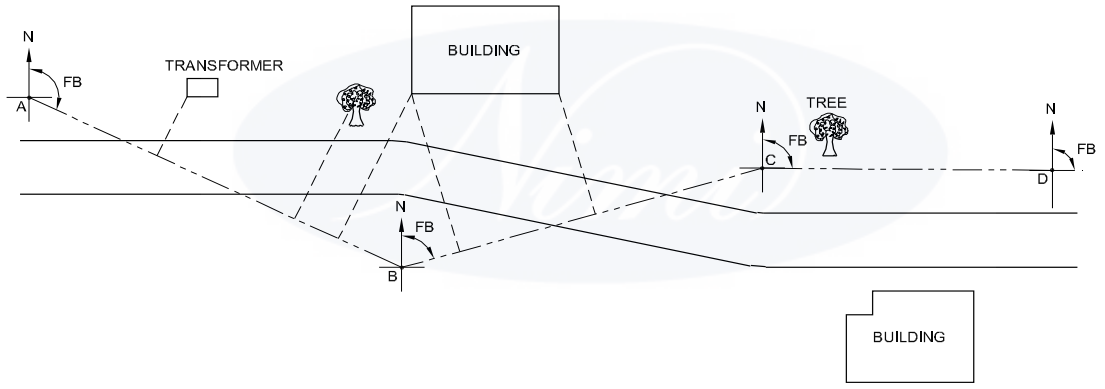
TASK 1 : **Prepare a road map with details along the road**

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,.

Fig 1



PLAN SHOWING THE ROAD PROFILE

SUN3594H1

4 Set up the instrument over the selected station ‘A’

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 for proposed flats for auto CAD commands.

Fig 1