INTERNATIONAL STANDARD

ISO 4463-2

First edition
1995-12-15

Measurement methods for building — Setting-out and measurement —

Part 2:
Measuring stations and targets

Méthodes de mesurage pour la construction — Piquetage et mesurage —
Partie 2: Stations et balises

Reference number
ISO 4463-2:1995(E)

Contents

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4463-2 was prepared by Technical Committee ISO/TC 59, *Building construction*, Subcommittee SC 4, *Dimensional tolerances and measurement*.

This first edition of ISO 4463-2, together with ISO 4463-1 and ISO 4463-3, cancels and replaces ISO 4463:1979, which has been technically revised.

ISO 4463 consists of the following parts, under the general title *Measurement methods for building — Setting-out and measurement*:

— *Part 1: Planning and organization, measuring procedures, acceptance criteria*

— *Part 2: Measuring stations and targets*

— *Part 3: Check-lists for the procurement of surveys and measurement services*

Annexes A and B of this part of ISO 4463 are for information only.

Measurement methods for building — Setting-out and measurement —

Part 2:
Measuring stations and targets

1 Scope

This part of ISO 4463 deals with the progressive stages of establishing and marking measuring stations and targets on building sites. The aspects covered are planning, functional needs and maintenance.

This part of ISO 4463 applies to measuring stations and targets in all types of building construction.

Examples of different stations and targets and location plans are given in annex A.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4463. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 4463 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of the IEC and ISO maintain registers of currently valid International Standards.

ISO 1803:—[1], *Building construction — Expression of dimensional accuracy — Vocabulary.*

ISO 4463-1:1989, *Measurement methods for building — Setting-out and measurement — Part 1: Planning and organization, measuring procedures, acceptance criteria.*

3 Definitions

For the purposes of this part of ISO 4463, the definitions given in ISO 1803 and ISO 4463-1 apply.

4 General

Stations and targets are the basis of all setting-out and measuring procedures. It is important that the locations of stations and targets are properly planned and constructed to meet their functional requirements throughout the building process. The requirements include the need for stability, accessibility and clear lines of sight throughout their useful life, wherever possible.

The type, quality and permanence of stations and targets depend on the particular project requirements in relation to the various categories of setting-out and measurement described in ISO 4463-1.

Planning and maintenance of stations and targets are essential to ensure reliable results.

5 Planning

5.1 Location

The locations of the stations and targets should be chosen to meet the requirements and conditions of the particular construction site. These may depend on:

1) To be published. (Revision of ISO 1803-1:1985, ISO 1803-2:1986 and ISO 4464:1980).

a) the type of construction and complexity;

b) the availability and suitability of the proposed locations for the stations and targets;

c) the intended locations of the site offices, stores and site construction roads;

d) the locations of underground utilities;

e) the ground conditions;

f) the period for which each station and target is required.

During the relevant stages of construction, it is important to keep essential lines of sight between stations and targets clear of all obstructions to enable the setting-out and subsequent check and compliance measurements to be made.

Stations should have easy access and sufficient working space to allow free movement around the point.

5.2 Approvals

Before establishing stations and targets outside the site, permission may be required from the adjacent property owner. Before establishing stations and targets on the construction site, it is recommended that the site manager is in agreement with the proposed locations. Each location should be indicated on both the site plan and the appropriate location plan.

5.3 Programme

A programme giving the time schedules for the establishment of the stations and targets should be prepared, which takes into account the construction schedule, the ground conditions, the accessibility to the building site and its location.

This programme should, wherever possible, include sufficient time to allow for relevant settlement and shrinkage to take place before the primary stations are used for measurement purposes.

6 Functional needs of stations and targets

6.1 Stability and durability

On the site there are many risks to the stability of measuring points, such as disturbance from site traffic and works, settlement in the ground due to proximity of excavation, blasting, load from heavy foundations and vibrations from traffic.

When constructing stations and targets, their design and materials should fulfil the needs of stability and durability. Examples of stations and targets are given in annex A.

6.2 Protection

Appropriate actions should be taken to protect stations and targets in vulnerable locations from disturbance by providing physical barriers such as posts and guard rails. Visual warnings such as buntings or painted rails should be provided.

Wall targets outside the site should be placed out of reach from the ground level.

6.3 Marking

Stations and targets should have distinct and unambiguous marks. For a specific site, all stations and targets should have unique referencing. These should be indicated on the location plan.

6.4 Station and target description

All important stations and targets should be described so that they can be located easily.

For each of these stations or targets, a description should be given that provides the following information:

a) location sketch indicating the position of the station or target in relation to an easily recognizable permanent feature or features (witness marks);

b) identity reference;

c) whether it concerns a station, target or benchmark;

d) form of construction;

e) coordinates or level value, as appropriate;

f) date.

Examples of descriptions for a station and a benchmark are given in figure 1.

a)

Date: *1988-05-12*

POINT DESCRIPTION X: *1 852,260* Y: *376,458* Z:

Project: *ABC Motor Works, Oldtown, LC Constr. Co.* Page: *1*

Point reference: *3* Type: *Primary*

ID-text: *PP3 LC*

Recognition signs: *See points 1-2 on sketch*

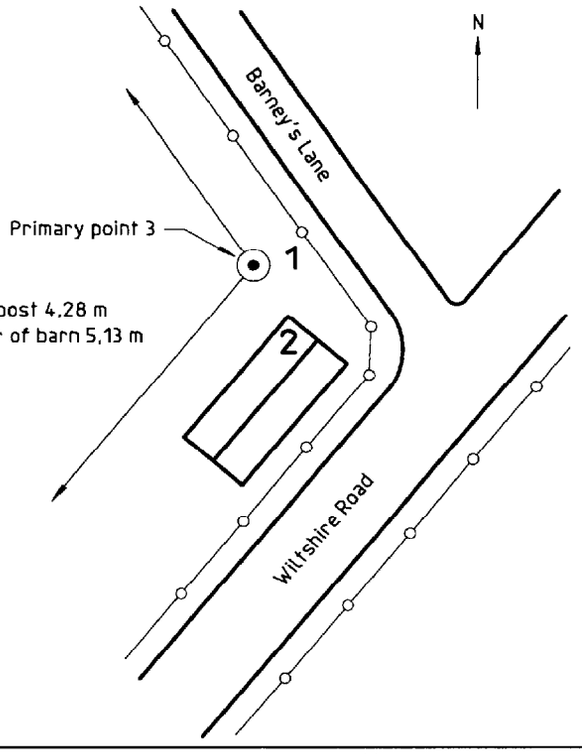
Witness marks: *Do not exist*

Coordinates: *See computer printout 1988-05-31, local coordinates*

Notes: *Steel pipe with ID-collar in earth-bound stone*

Drawn up by: *TR*

Sketch



b)

Date: *1988-05-30*

POINT DESCRIPTION X: Y: Z: *+18,258*

Project: *Forsyth Brokers, Newtown, LC Constr. Co.* Page: *2*

Point reference: *12* Type: *BM*

ID-text: *BM12 LC*

Recognition signs: *See points 1-2 on sketch*

Witness marks: *Do not exist (Master Benchmark on 54 Curzon Cr.)*

Coordinates: *+18,258 m in Newtown local height system*

Notes: *Steel stud with ID-collar in building foundation*

Drawn up by: *TR*

Sketch

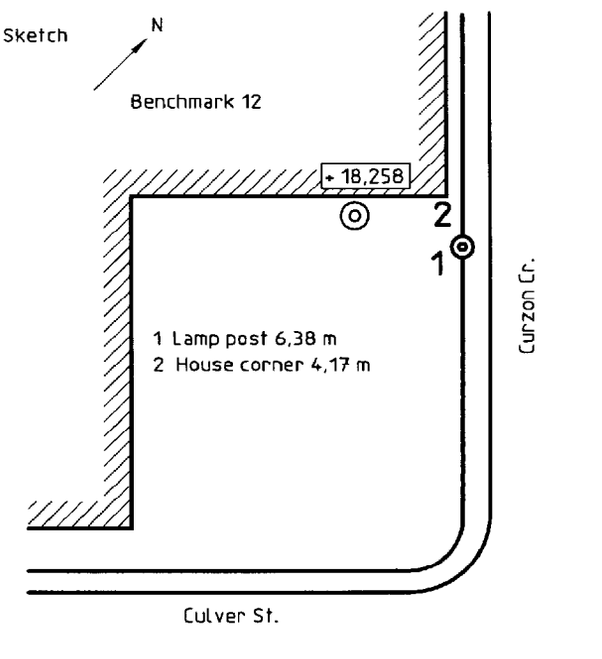


Figure 1 — Examples of forms for point description

7 Maintenance

7.1 Visual

The first stage of inspection is to look for any visible indication of changed status; i.e. damage, movement or instability of a station or target.

7.2 By measurement

An inspection by measurement should be made when the integrity of the station or target appears to have been disturbed, or at the time of handing over the responsibilities for the established setting-out system.

When the inspection reveals that the existing station or target is not valid or is unstable, wherever possible, correct location of the station or target should be reinstated or an alternative station or target established in a stable location.

An up-to-date record should be kept of any changed status, or re-instatements, or of new positions of stations and targets

Annex A
(informative)

Examples of stations and targets

A.1 This annex gives examples of measuring stations and targets (figures A.1 to A.18) and an example of measuring points and targets (figure A.19). It includes a Guide (table A.1) which is subdivided according to the main uses of the stations and targets.

This annex also includes two examples of a location plan of stations and targets (figures A.20 and A.21) and a list of symbols to be used on location plans (table A.2).

A.2 The duration of stations and targets varies greatly for particular stations and targets on specific sites, but is in general assumed to be the following:

a) short term: up to 1 month;

b) medium term: up to 1 year;

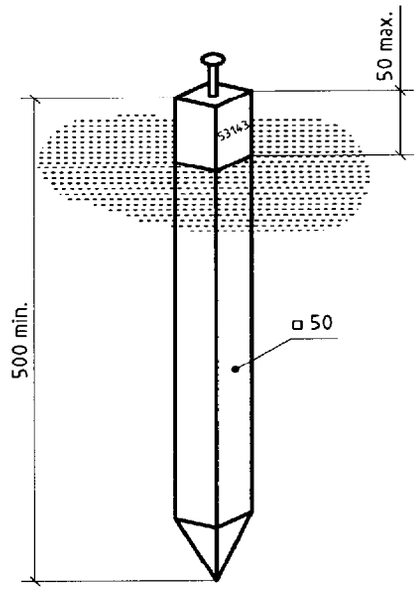
c) long term: at least for the duration of the building project.

Table A.1 — Guide to facilitate the use of annex A

Example No.		Detail points	Targets	Markers	Point protection	Location plan of stations and targets
Primary points	Secondary points					
		1				
2	2					
3 BM						
4	4 BM					
5 BM						
6	6	6				
	7			7		
	8 BM					
			9			
10				10		
	11					
		12	12			
13 BM				13		
14 BM	14 BM					
15 BM						
16 BM						
					17	
					18	
19			19			
						20
						21

BM = benchmark
The numbers refer to figures A.1 to A.21.

Dimensions in millimetres



Type: Wooden peg.

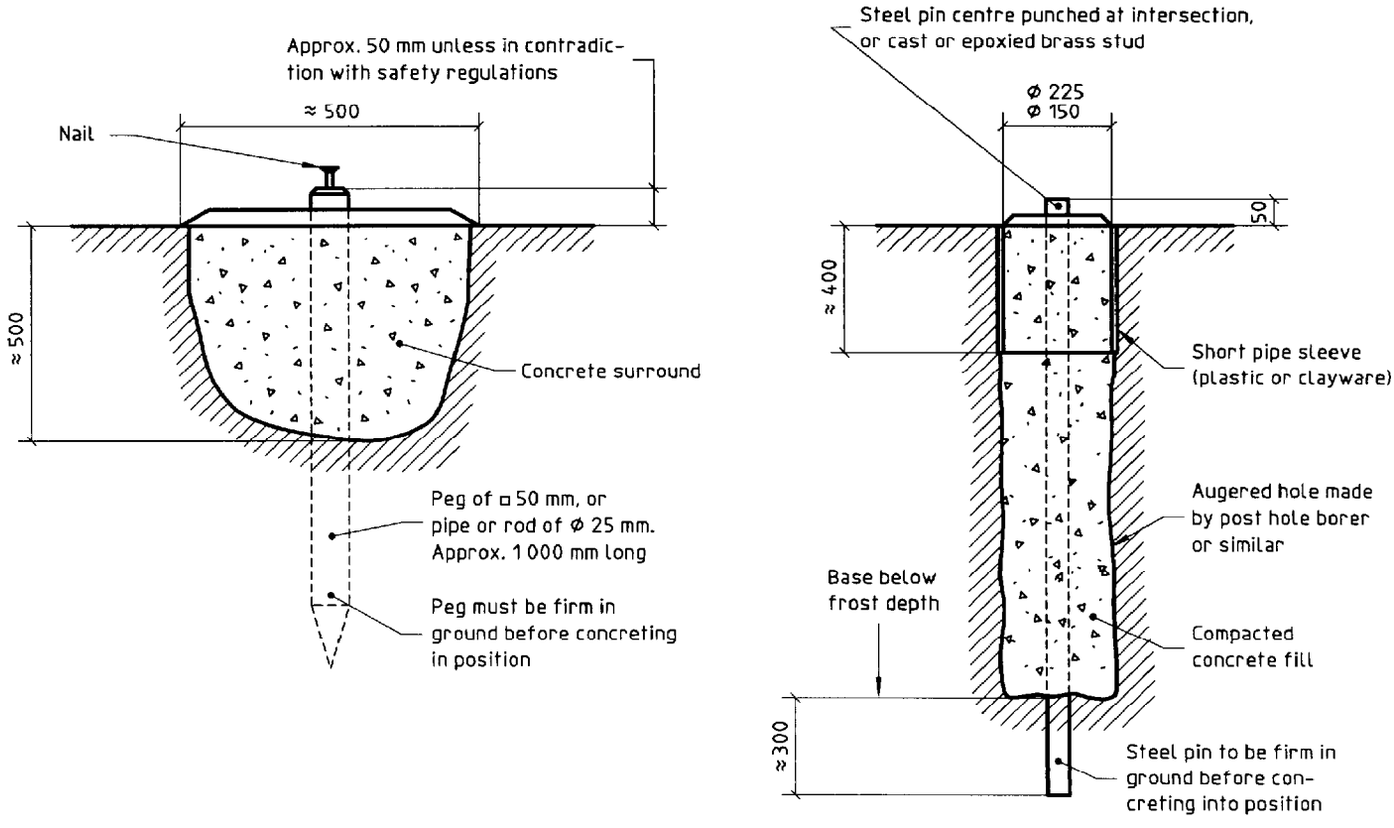
Main uses: Corner points, earthworks, street kerbs.

Duration: Short term.

Precautions: May not be suitable where frost heave can occur.

Figure A.1 — Stations and targets: Example 1

Dimensions in millimetres



a) Dug hole with peg in concrete surround

b) Augered hole filled with concrete

Type: *In-situ* cast concrete block in dug or augered hole.

Main uses: Primary and secondary points within boundary of site.

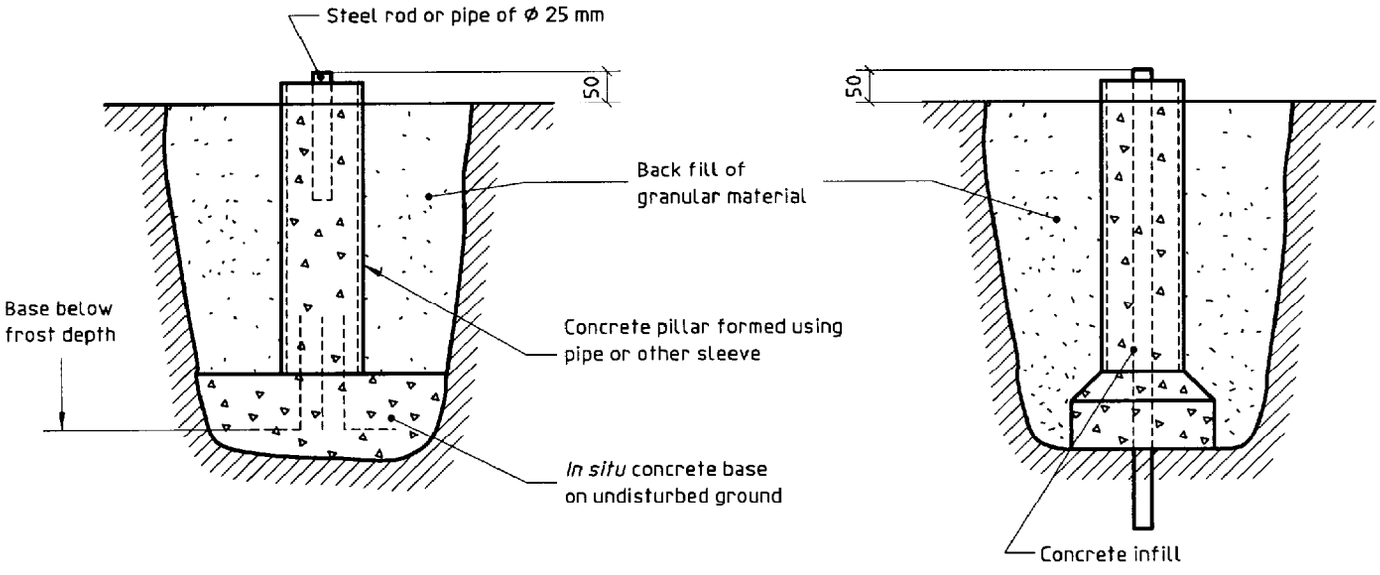
Duration: Type a): medium term;
Type b): long term.

Precautions: To be positioned so as not to be affected by site traffic or operations.

NOTE — Type a) is not suitable for areas with frost heave.

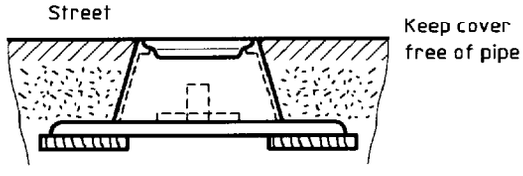
Figure A.2 — Stations and targets: Example 2

Dimensions in millimetres



a) Concrete pillar on concrete base

b) Concrete pillar using pipe sleeve with rod driven into undisturbed ground



c) Example of protection for station below ground level [applies to both alternatives a) and b)]

Type: *In situ* pillar using pipe or other sleeve.

Main uses: Primary points and benchmarks. (The material can usually be obtained on site.)

Duration: Long term.

Precautions: Should be well marked and protected from vehicle/machinery damage.

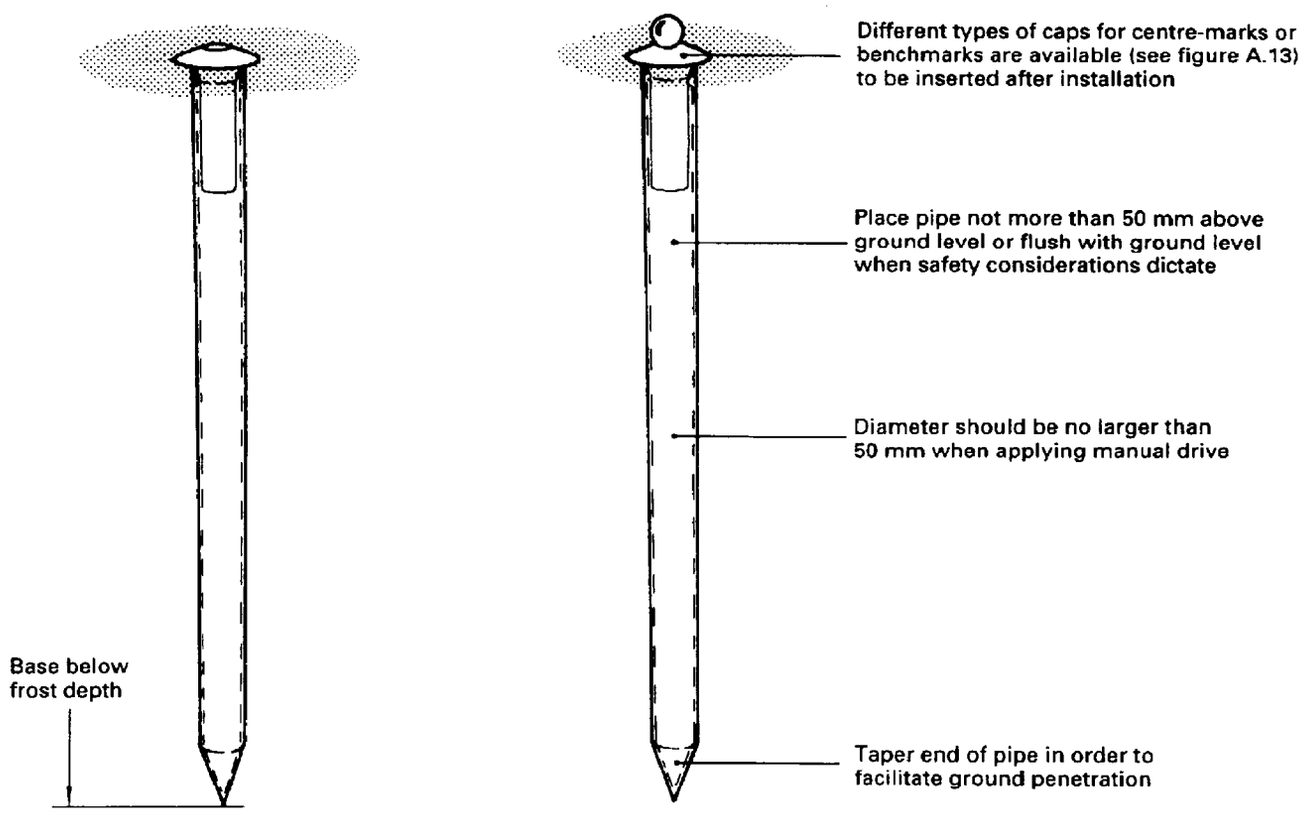
NOTES

1 Suits most ground conditions even where frost heave can occur.

2 See figure A.13 for example of marker in upper end of steel.

3 See figures A.17 and A.18 for examples of station protection.

Figure A.3 — Stations and targets: Example 3



Type: Driven pipe.

Main uses: Primary and secondary points or secondary benchmarks.

Duration: Long term.

Precautions: For depths larger than 1 m, use a post hole digger or pipe with multiple sections and ensure connections are tight.

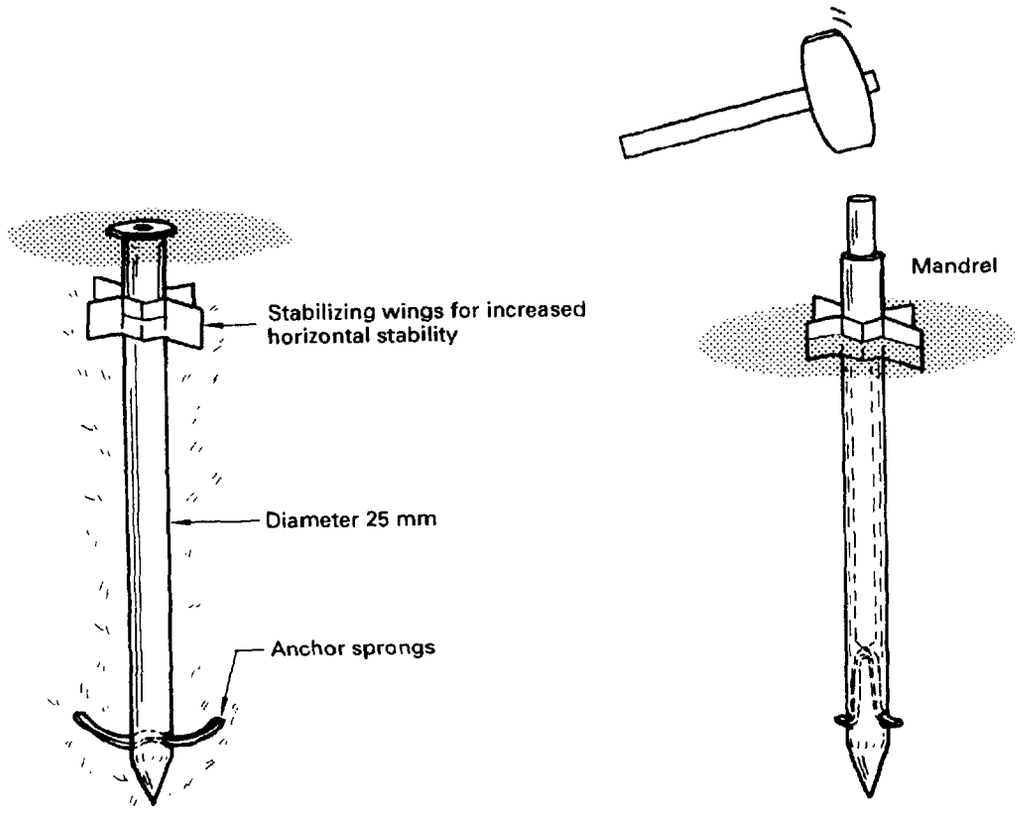
Use driving adapter or "dead-blow" hammer to prevent damage on top of pipe.

NOTES

1 Suits ground conditions where frost heave can occur.

2 Steel pipe from site or pipe makers are commercially available.

Figure A.4 — Stations and targets: Example 4



Construction

Drive down pipe to about 100 mm above desired depth (at least the frost depth). Push out the anchor sprongs with mandrel. Drive pipe down over the remaining 100 mm of the desired depth. Remove mandrel and insert marker or benchmark stud.

Type: Pipe with anchor sprongs and stabilizing wings.

Main uses: Primary points and benchmarks, especially for long-term projects and/or in areas with frost heave.

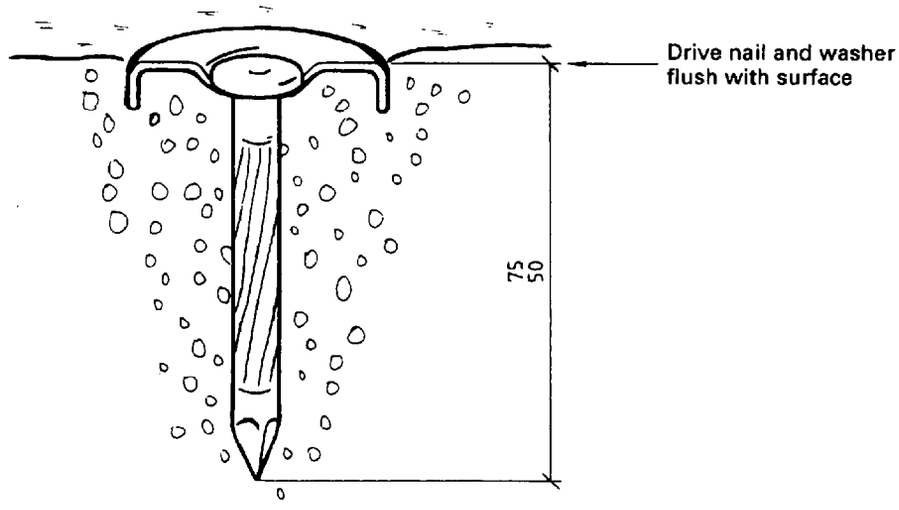
Duration: Long term.

Precautions: In stony ground, use hard steel points and drill the first 0,5 m of the desired depth with post-hole digger.

NOTES
1 Several types are commercially available .
2 See figure A.13 for example of marker.
3 See figures A.17 and A.18 for examples of station protection.

Figure A.5 — Stations and targets: Example 5

Dimensions in millimetres



Type: Nail and identification washer.

Main uses: Auxiliary points or, when necessary, primary or secondary points.

Duration: Medium term.

Precautions: Surround nail with paint for easy identification. Enquire whether the area is to be resurfaced in the near future.

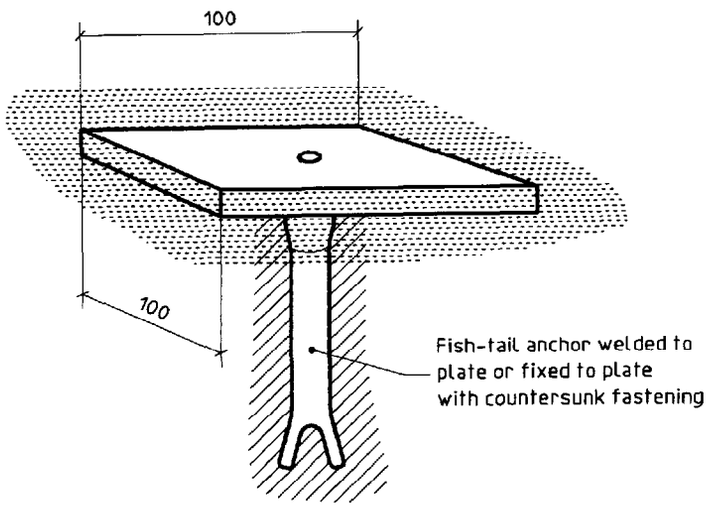
NOTES

1 Used in asphalt or tarmac surfaces.

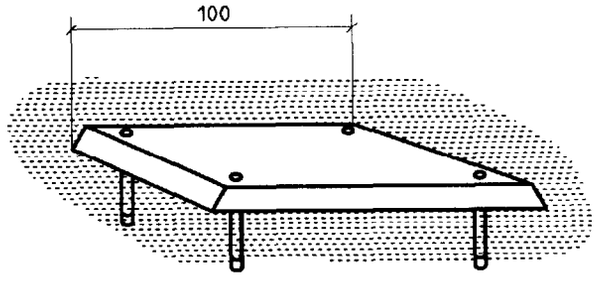
2 Several types are commercially available.

Figure A.6 — Stations and targets: Example 6

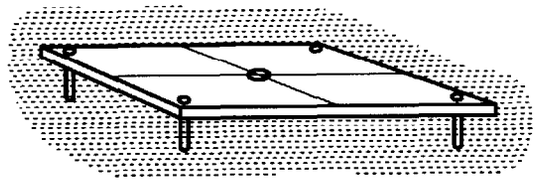
Dimensions in millimetres



a) Plate inserted into wet concrete flush with surface



b) Plate fixed to concrete surface after casting
(Fixing provided by drilling and plugging to receive countersunk screws or, alternatively, use expanding anchors)



c) Thin plate fastened with steel nails or epoxy adhesive

Type: Steel plate in concrete (e.g. concrete slab).

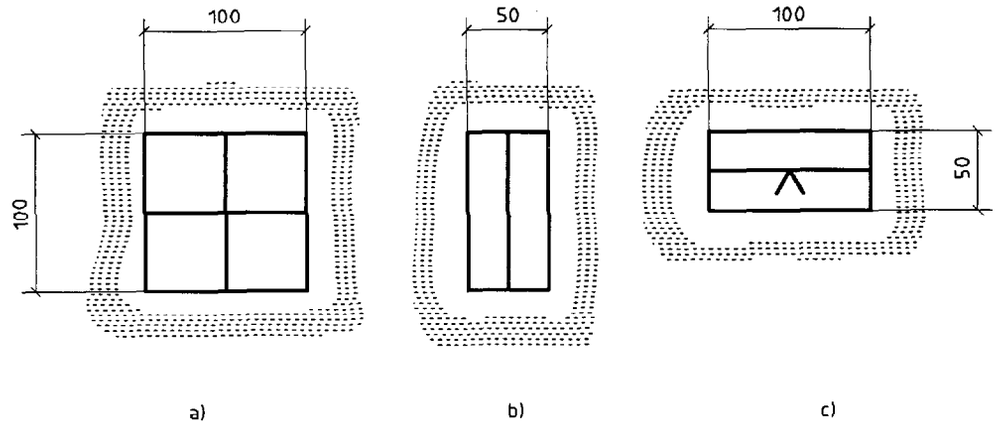
Main uses: Marking secondary points (e.g. mark drilled, punched or scratched in the plate) for further setting-out and/or compliance measurements at a later stage.

Duration: Medium term to long term.

Precautions: Type a): Top of plate should be flush with surface of concrete.
Type b): If plate is fixed to concrete surface after casting, plate edges should be tapered to prevent people tripping.
Also check safety regulations on site.

Figure A.7 — Stations and targets: Example 7

Dimensions in millimetres



Type: Painted marks with pencil lines, on floors and walls.

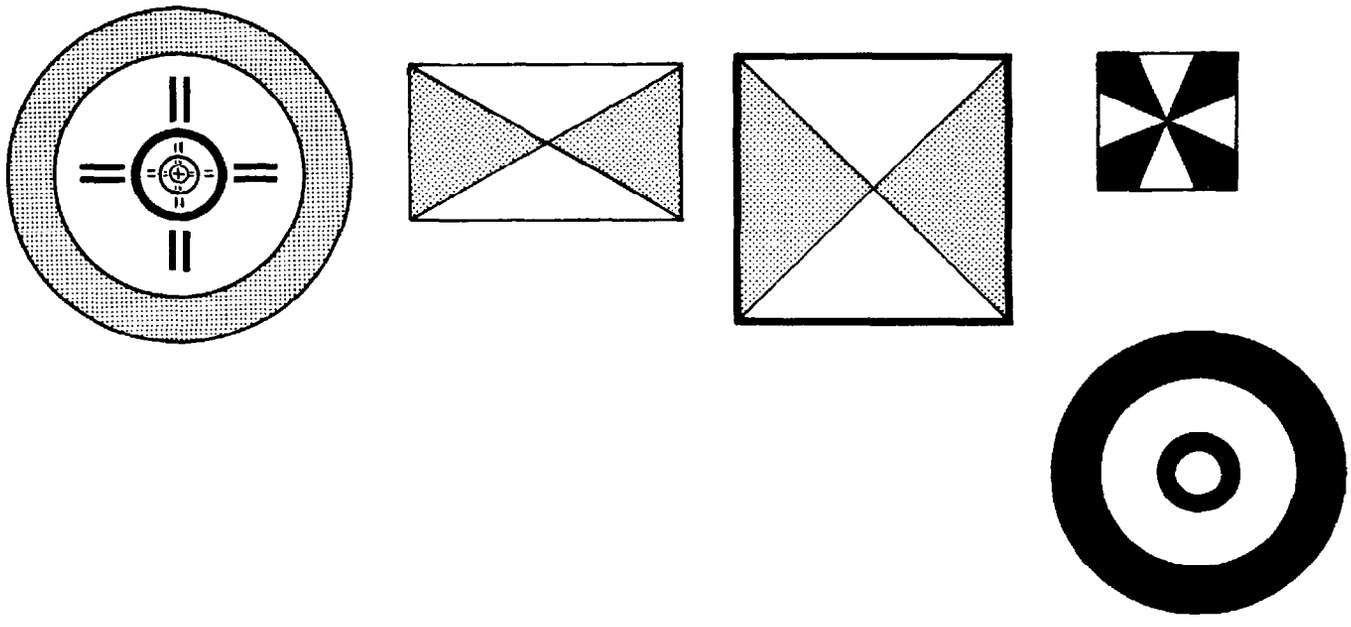
Main uses: Type a): grid points and plumbing points.
Type b): secondary points.
Type c): benchmarks.

Duration: Short term.

Precautions: Paint marks or wax crayons should not be used on finished elements of work.
Instead of painted marks, adhesive labels can be used, see figure A.9.

NOTE — To promote accurate sighting, the thickness of the pencil lines should not exceed 0,5 mm for sighting distances up to 50 m, and 1 mm for 100 m.

Figure A.8 — Stations and targets: Example 8



Minimum dimensions for primary points: 200 mm
Minimum dimensions for secondary points: 100 mm

Apply high-contrast colours (e.g. white, black, yellow and red)

Type: Wall targets, elevated targets, aiming targets.

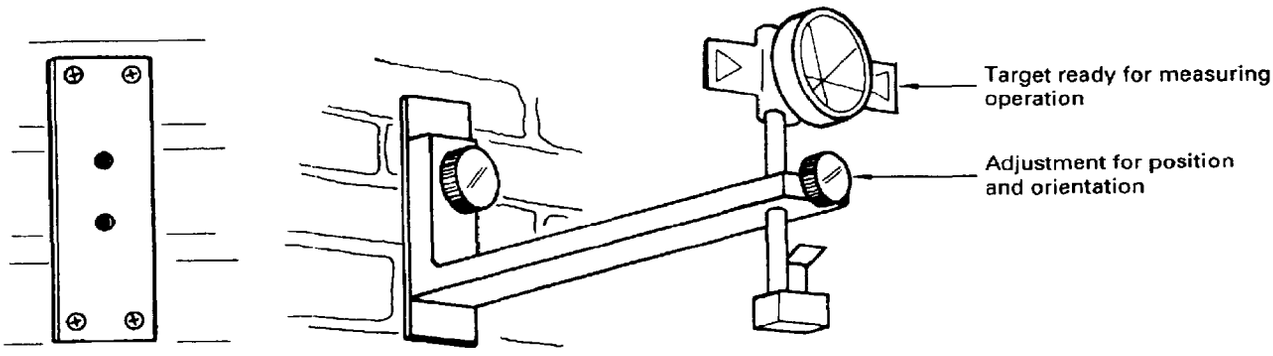
Main uses: Combined measuring point and aiming target.

Duration: Medium term.

Precautions: Surfaces shall be smooth to avoid aiming errors due to asymmetrical reflections from illumination sources. This can be the case with targets painted by hand on walls or thin self-adhesive targets.
Level target before final fixing of position.
Screw fixing should be used.

NOTES
1 Various types are commercially available.
2 When used in conjunction with EDM, the target should be suitable for the particular equipment used.

Figure A.9 — Stations and targets: Example 9



Type: Detachable wall-mounted target.

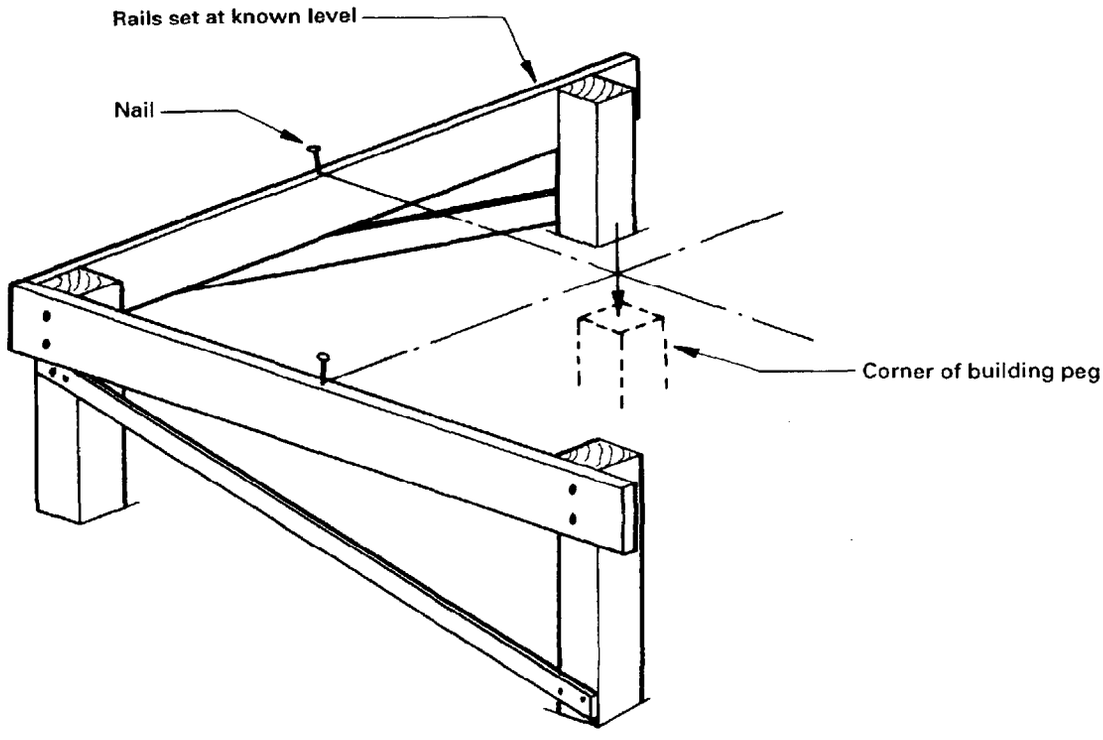
Main uses: Primary points, especially when site operations do not allow other markers, or when coverage of ground points by ice and snow is expected.

Duration: Long term.

Precautions: Height above ground should be about 2 m to ensure clear lines of sight.
When using several brackets, make sure their dimensions are consistent. Avoid buildings which are likely to be subject to deformation.
Obtain permission from the building owner.
When necessary, drill out the slots of the screws so that removal of the plate will be difficult.

NOTE — The coordinate point is not the hole in the wallplate but the centre of the target after levelling the bull's eye.

Figure A.10 — Stations and targets: Example 10



Type: Corner profile.

Main uses: Marking building line, wall faces from corner points.

Duration: Short term.

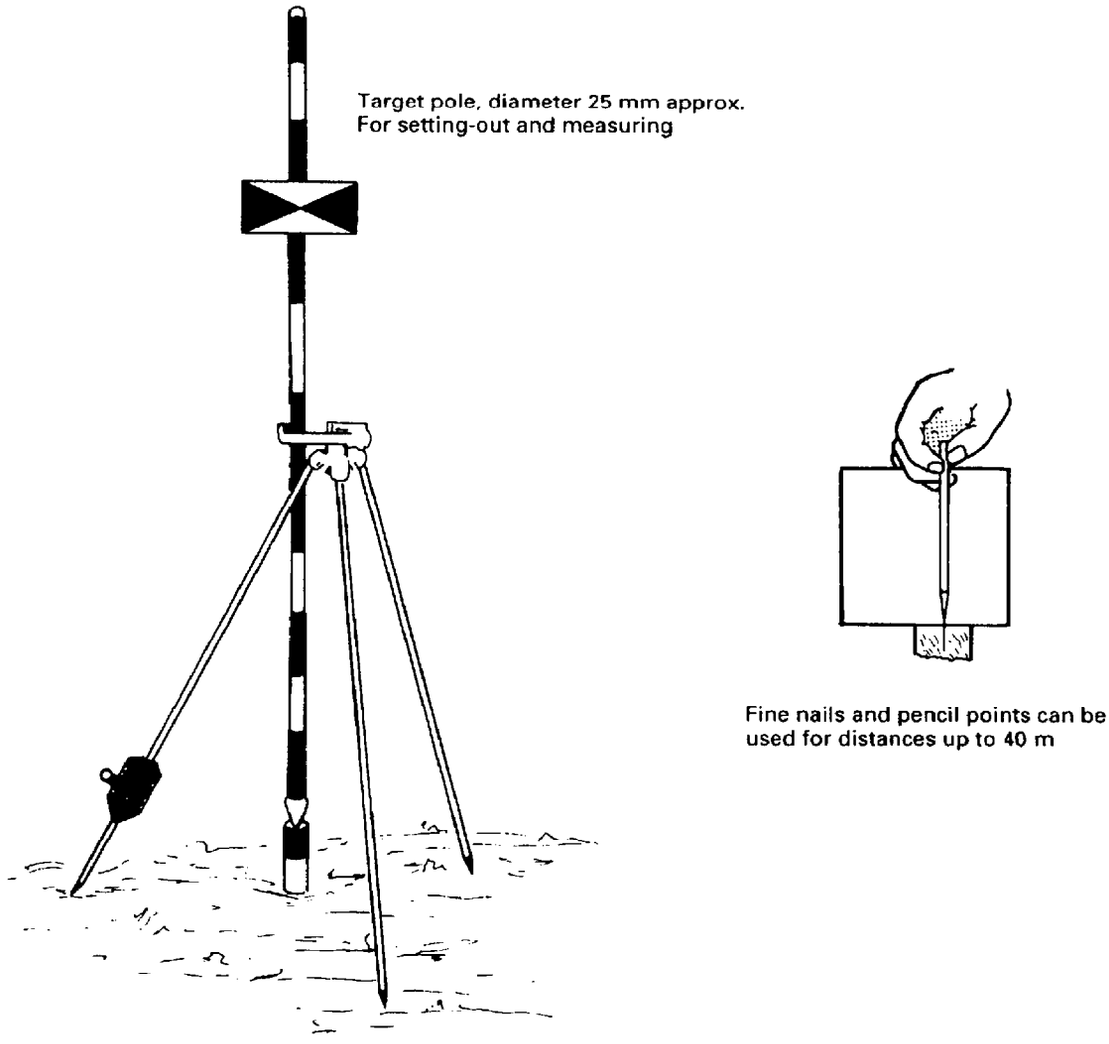
Precautions: Place profiles so that they will not be disturbed by subsequent excavation and will not obscure visibility.

NOTES

1 Rails should be horizontal and approximately at right angles to the line to be marked.

2 Allowance should be made for excavation work.

Figure A.11 — Stations and targets: Example 11



Type: Range rods, target poles, nails and pencil points.

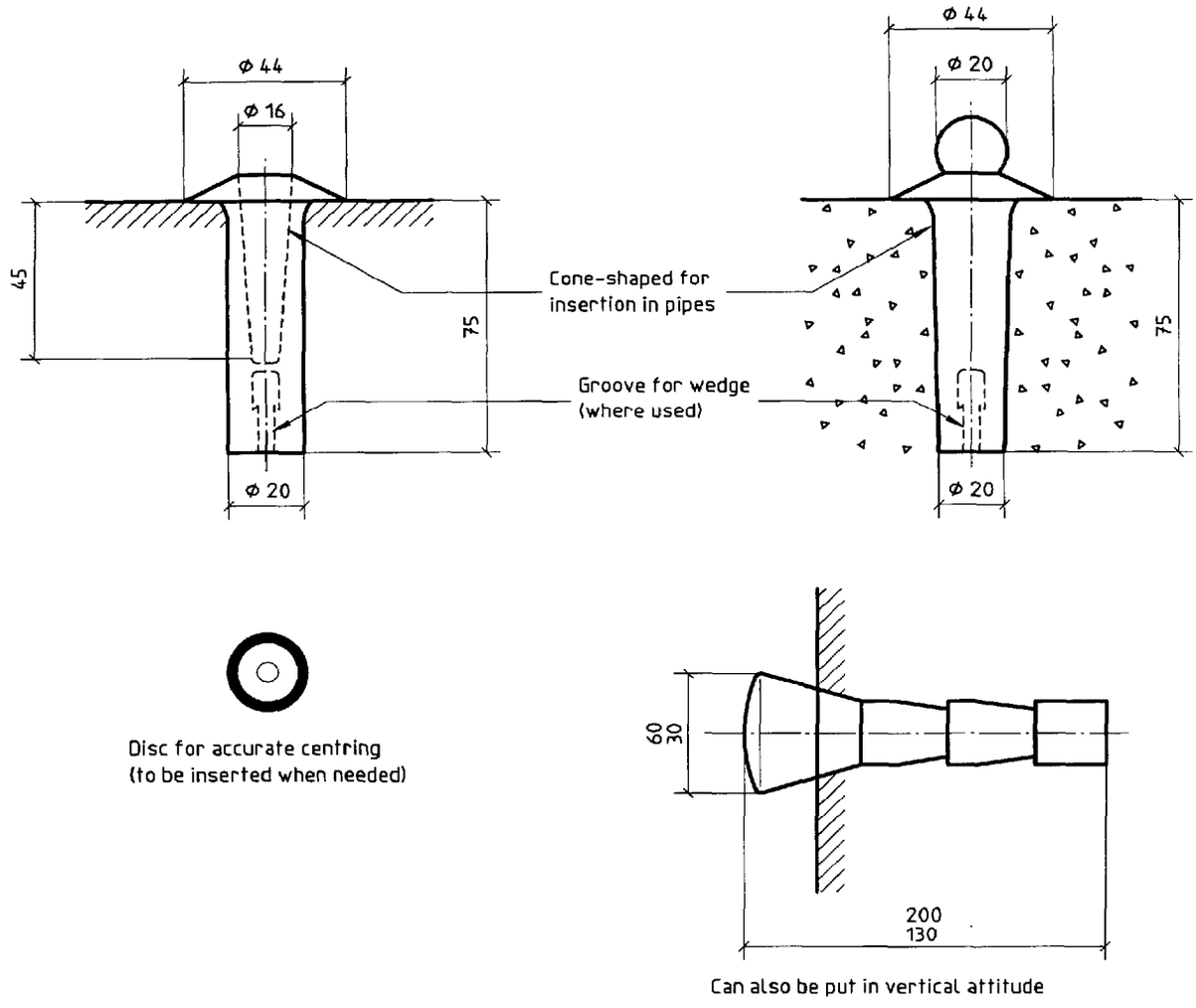
Main uses: To facilitate measurements between instrument and ground marks.

Duration: Short term.

Precautions: For rods and poles, steel shoes should fit in pipes or studs used on site.
Check verticality (e.g. with bull's eye level).
Deviation from straightness should be no more than 4 mm.
Use rods with fluorescent paint.

Figure A.12 — Stations and targets: Example 12

Dimensions in millimetres



Type: Metal markers and studs.

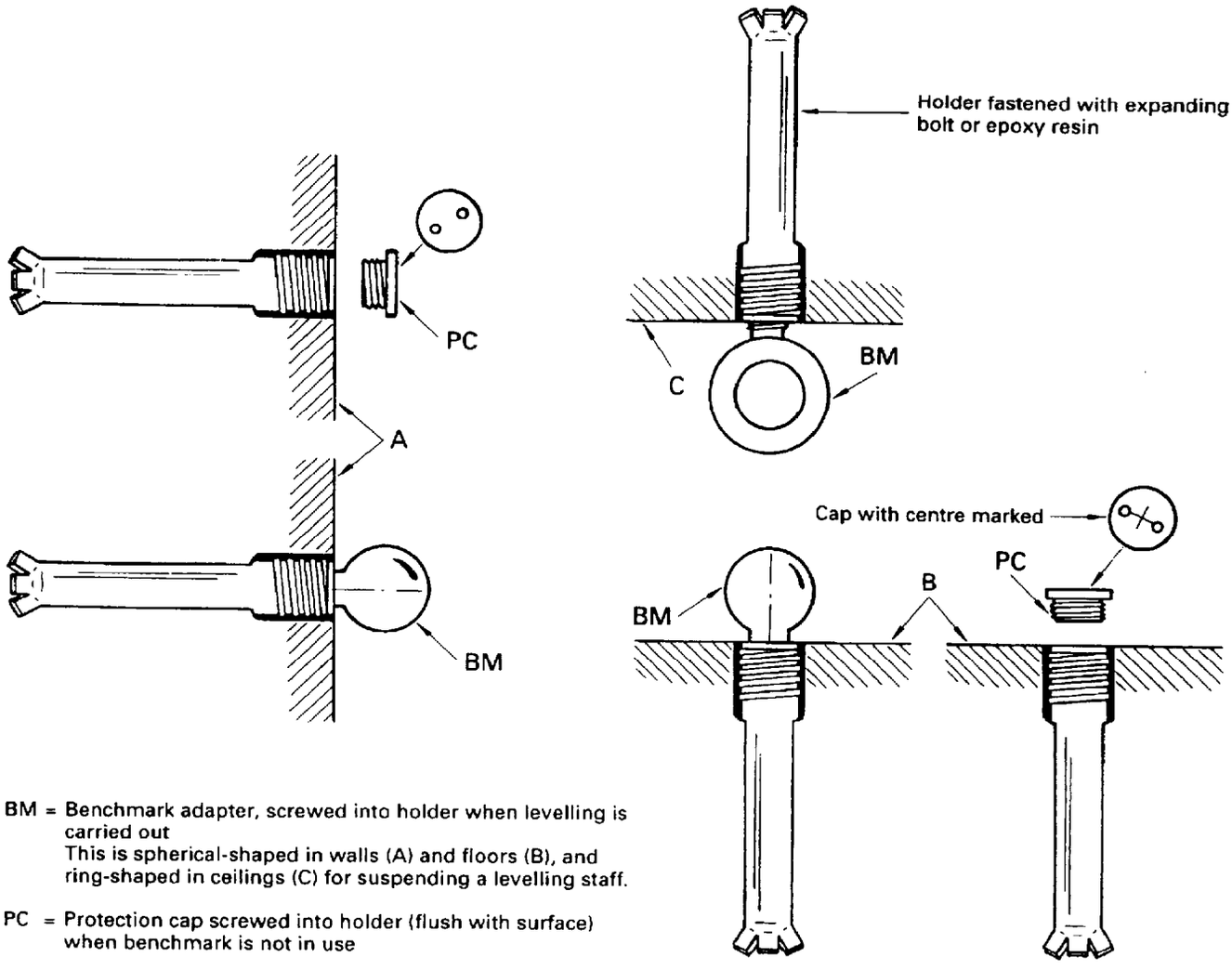
Main uses: Primary points and benchmarks.

Duration: Long term.

Precautions: Make sure there is tight contact between the collar of the marker and the material in which it is inserted. For accurate centring of instrument, insert centring adapter in marker.

NOTE — To be used directly in bedrock, concrete, masonry or on a steel pipe (see figures A.3 to A.5).

Figure A.13 — Stations and targets: Example 13



BM = Benchmark adapter, screwed into holder when levelling is carried out
This is spherical-shaped in walls (A) and floors (B), and ring-shaped in ceilings (C) for suspending a levelling staff.

PC = Protection cap screwed into holder (flush with surface) when benchmark is not in use

Type: Benchmarks.

Main uses: Primary and secondary benchmarks in areas where heavy site actions are going on or where other types of benchmarks might be damaged or might cause injury.

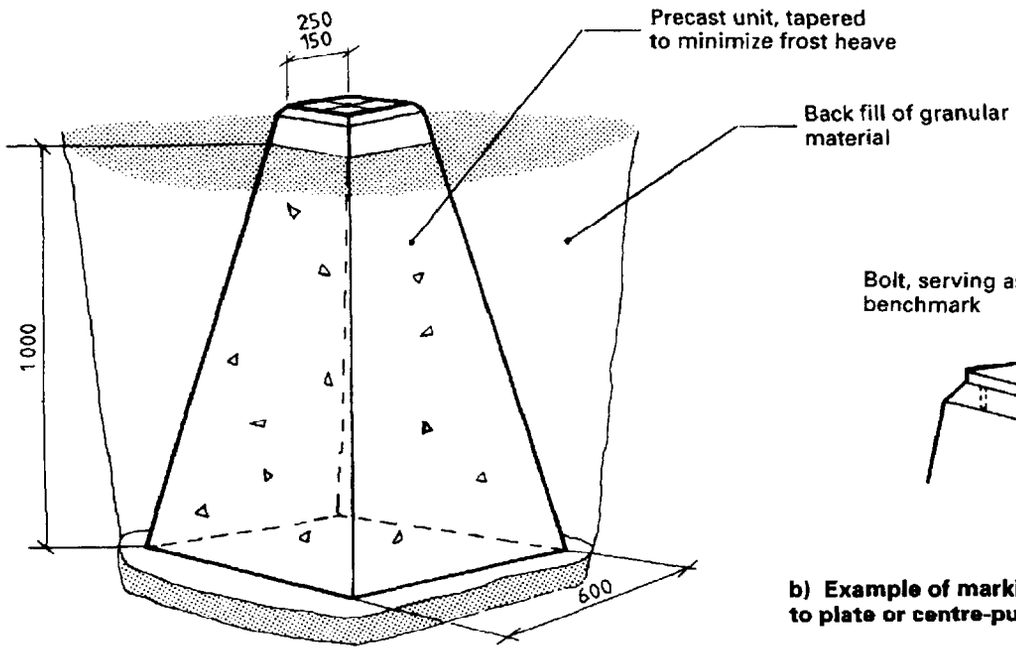
Duration: Long term.

Precautions: Primary benchmarks are not to be placed in locations subject to settlement.
Select location so that projecting building parts do not prevent the levelling staff from being held vertically.
Screw on protection cap immediately after use to protect the threads in the holder from damage.

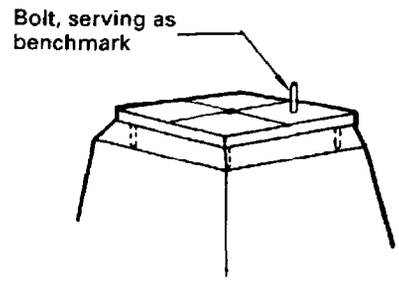
NOTE — Various types are commercially available.

Figure A.14 — Stations and targets: Example 14

Dimensions in millimetres



a) **Bedded on mortar or sand**



b) **Example of marking: Intersection lines scribed on to plate or centre-punched mark or drilled hole**

Type: Precast concrete block (with or without top metal plate).

Main uses: Primary points and benchmarks.

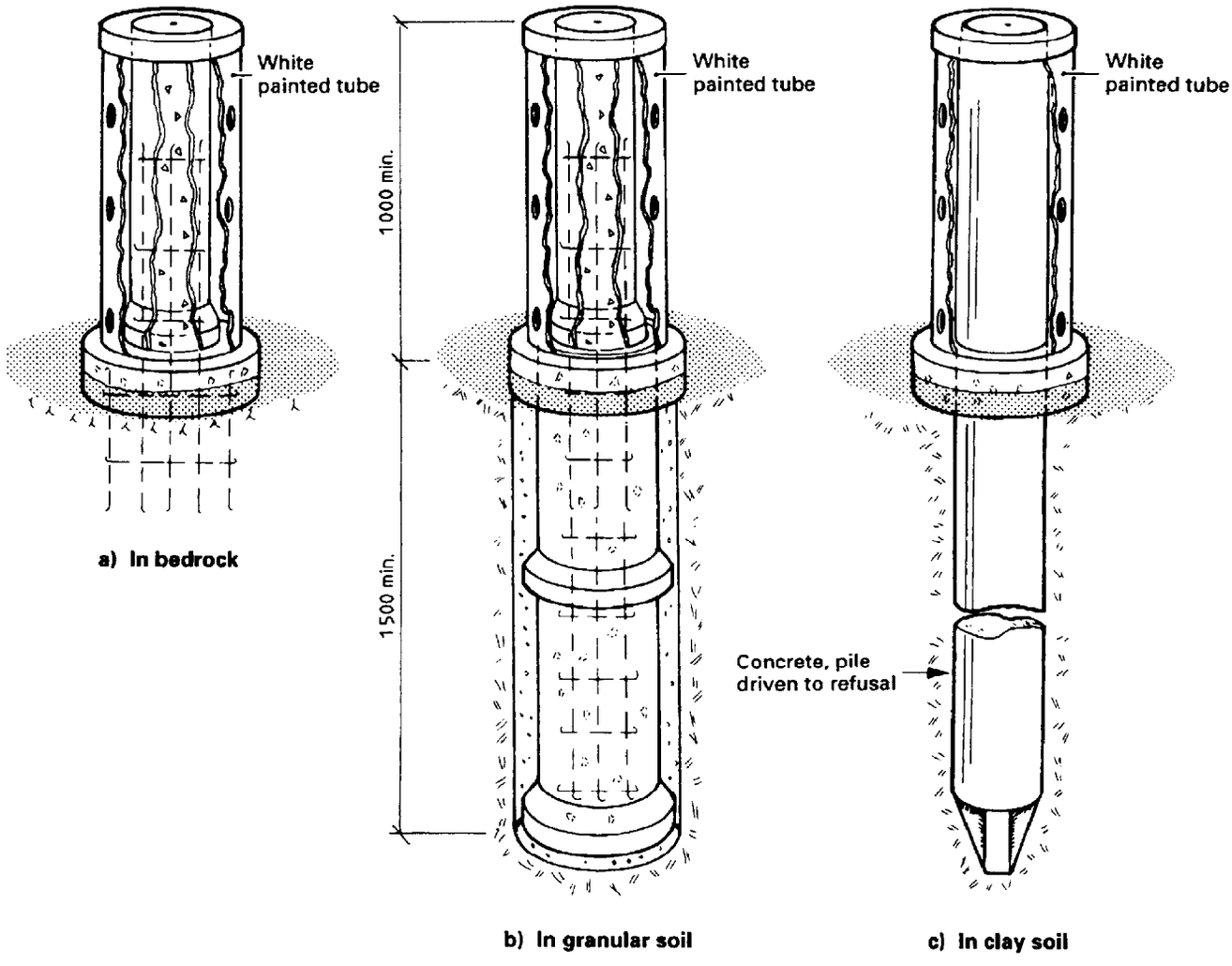
Duration: Long term.

Precautions: Very heavy; will need mechanical handling.
Bedding for precast block needs to be carefully prepared.

NOTES
1 Suits ground conditions where frost heave can occur.
2 In some countries, these types are used for marking boundaries of properties and are, as such, commercially available.
3 Seldom used on building sites.

Figure A.15 — Stations and targets: Example 15

Dimensions in millimetres



Type: Observation pillar.

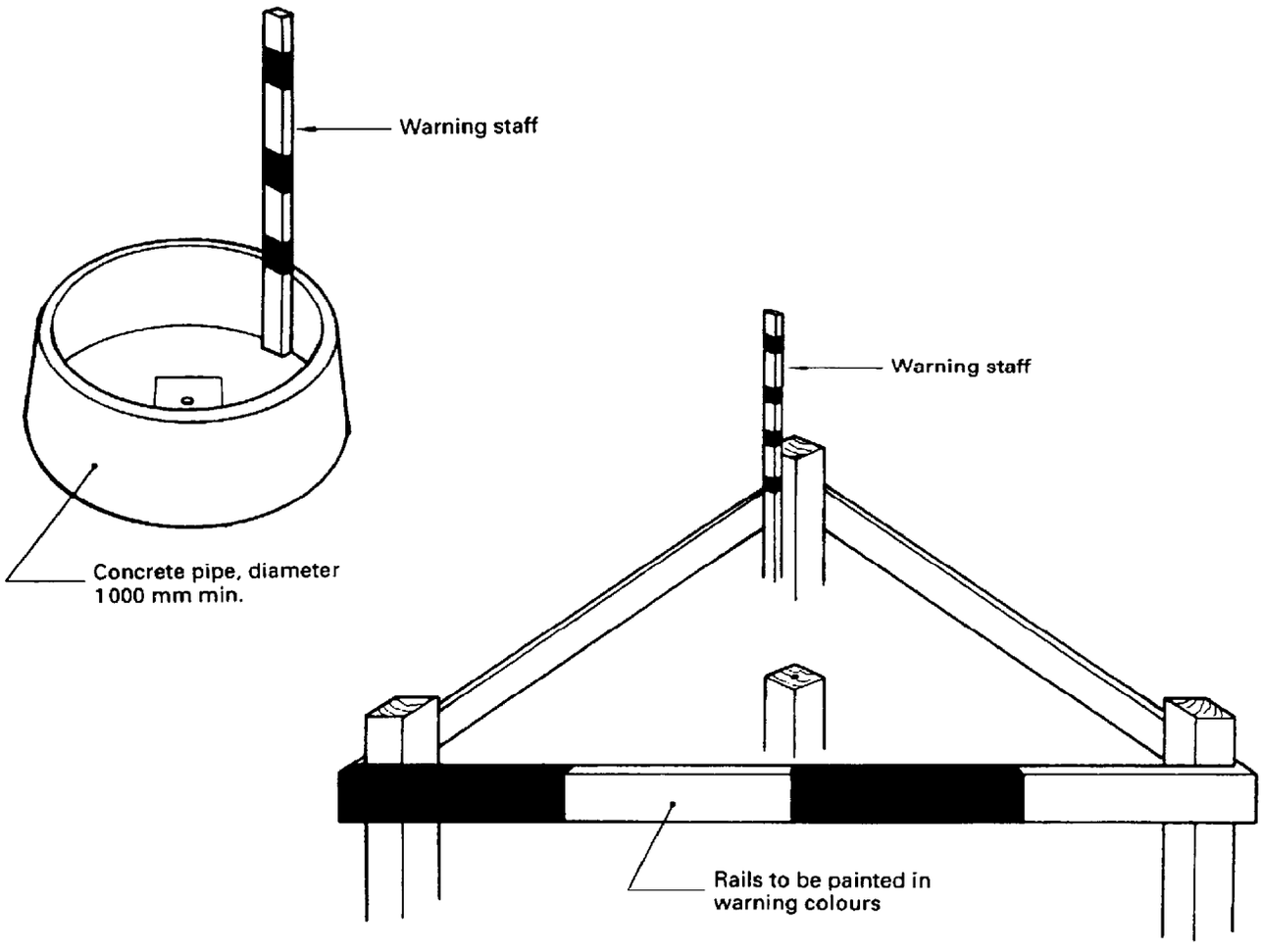
Main uses: Primary points for long-term projects (setting-out and deformation measurements).

Duration: Long term.

Precautions: To be located so as to avoid site traffic.
Provide station protection (see note on figure A.17).

NOTE — Can also be provided with benchmark.

Figure A.16 — Stations and targets: Example 16



Type: Station protection.

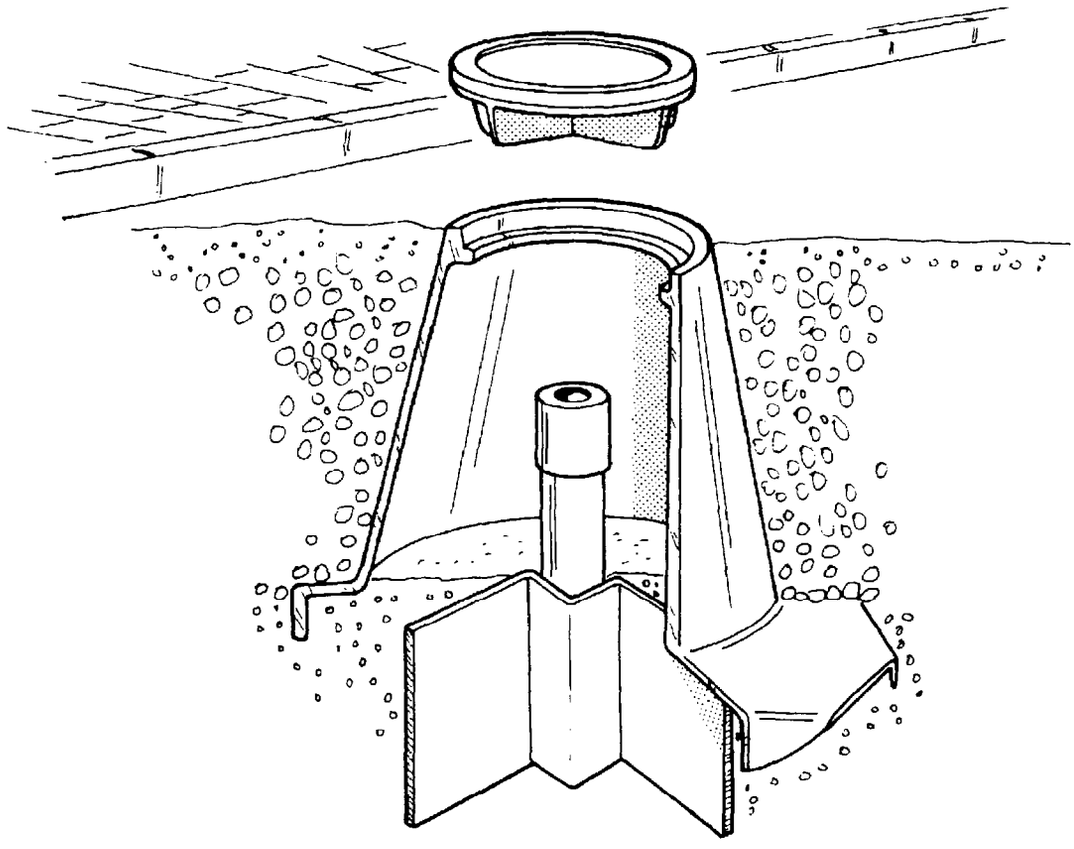
Main uses: To protect measuring points and benchmarks.

Duration: Medium term.

Precautions: Inside area should be large enough to allow instrument to be set up where possible.
One side should be easily removable for access to instrument and to provide more room to work.

NOTE — In particularly hazardous positions, the guard rails and posts should be replaced by scaffolding to give greater protection.

Figure A.17 — Stations and targets: Example 17



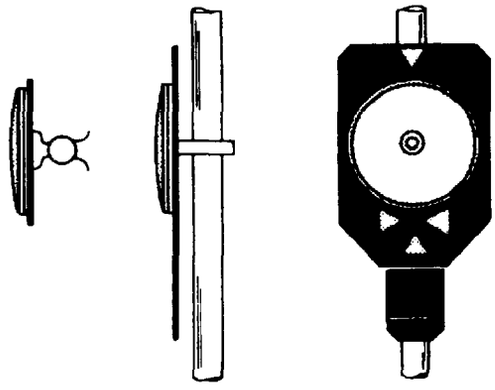
Type: Station protection.

Main uses: To protect measuring points marked below surface.

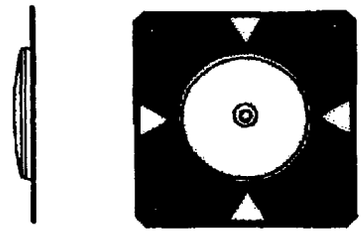
Duration: Long term.

Precautions: Enquire whether area will be resurfaced in near future.

Figure A.18 — Stations and targets: Example 18



a) **Plastic reflector and aiming target with clip to be fastened onto measuring rod**



b) **Plastic reflector and aiming target to be mounted on wall, usually fastened with screws**

Type: Short-range reflector, usually made of plastic materials.

Main uses: As reflector (and target) on rod for polar setting-out.
As permanent wall-mounted target in primary nets.

Duration: Medium term.

Precautions: To be checked, together with a particular EDM instrument, for measuring range, accuracy at right angle to the line of sight, and possible loss of accuracy at other angles of incidence.

Additional information: Testing procedure is given in ISO 8322-10.
If the manufacturer of the EDM instrument recommends a certain type of short-range reflector, the testing will be simplified.

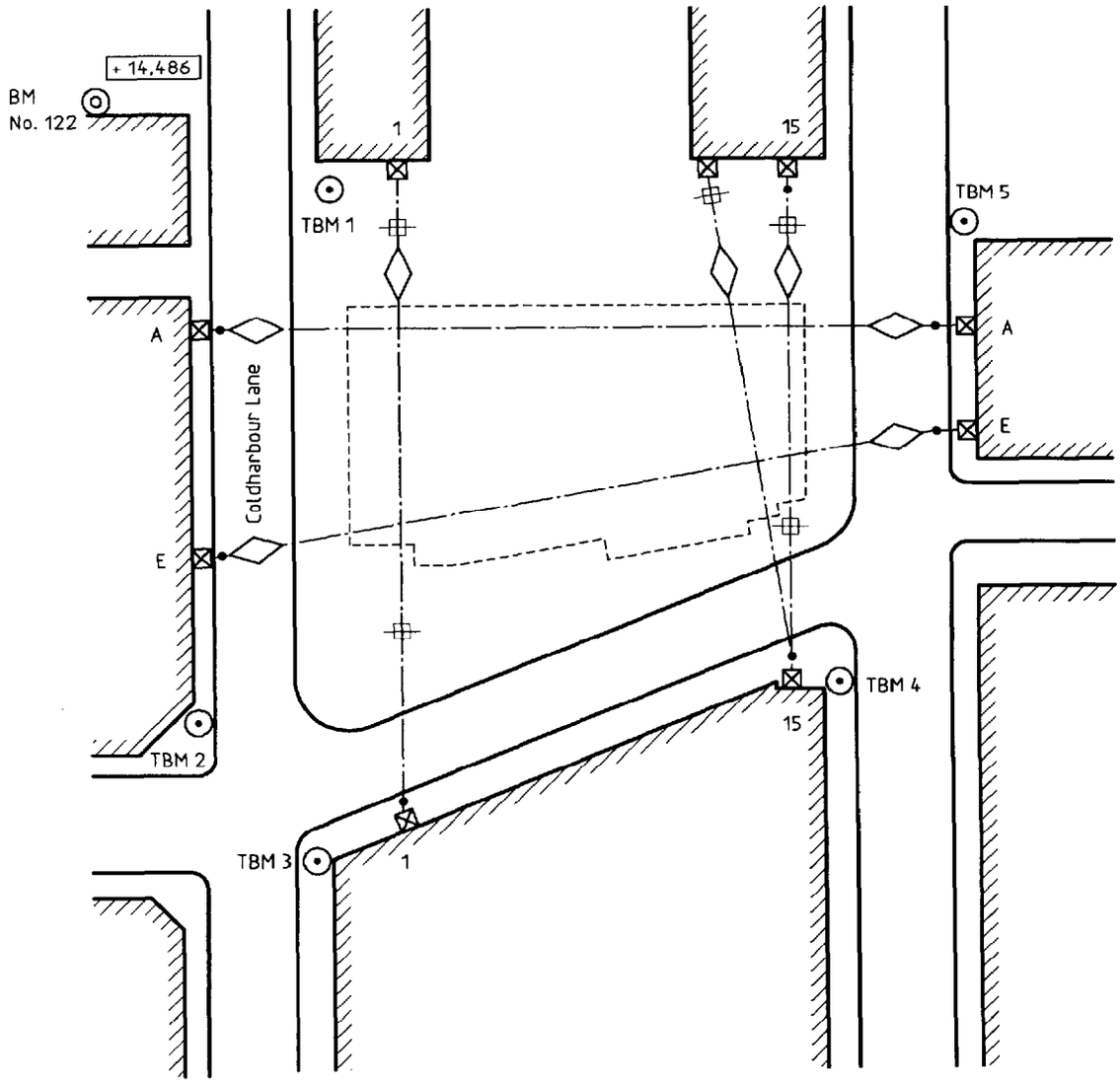
NOTE — Design of aiming targets may vary to suit different EDM designs.

Figure A.19 — Measuring points and targets: Example 19

A.3 The setting-out plan is an important requirement to ensure that there is a record of how stations and targets are located for reference and checking.

Two alternative examples, figures A.20 and A.21, illustrate two different principles.

Figure A.20 shows a grid system. Setting-out is performed from certain fixed points and lines and preferably only certain predetermined points and lines are set-out.



Key

◎	Primary benchmark
⊙	Temporary benchmark
⊕	Peg set in concrete (instrument station)
•	Nail
⊠	Elevated target

NOTES

1 All site levels related to benchmark BM No. 122 Coldharbour Lane.
2 Site levels are TMBs 1 to 5.
3 Grids No. 1 to 15 and A to E.
4. For symbols, see table A.2.

Figure A.20 — Example of a setting-out plan (grid system)

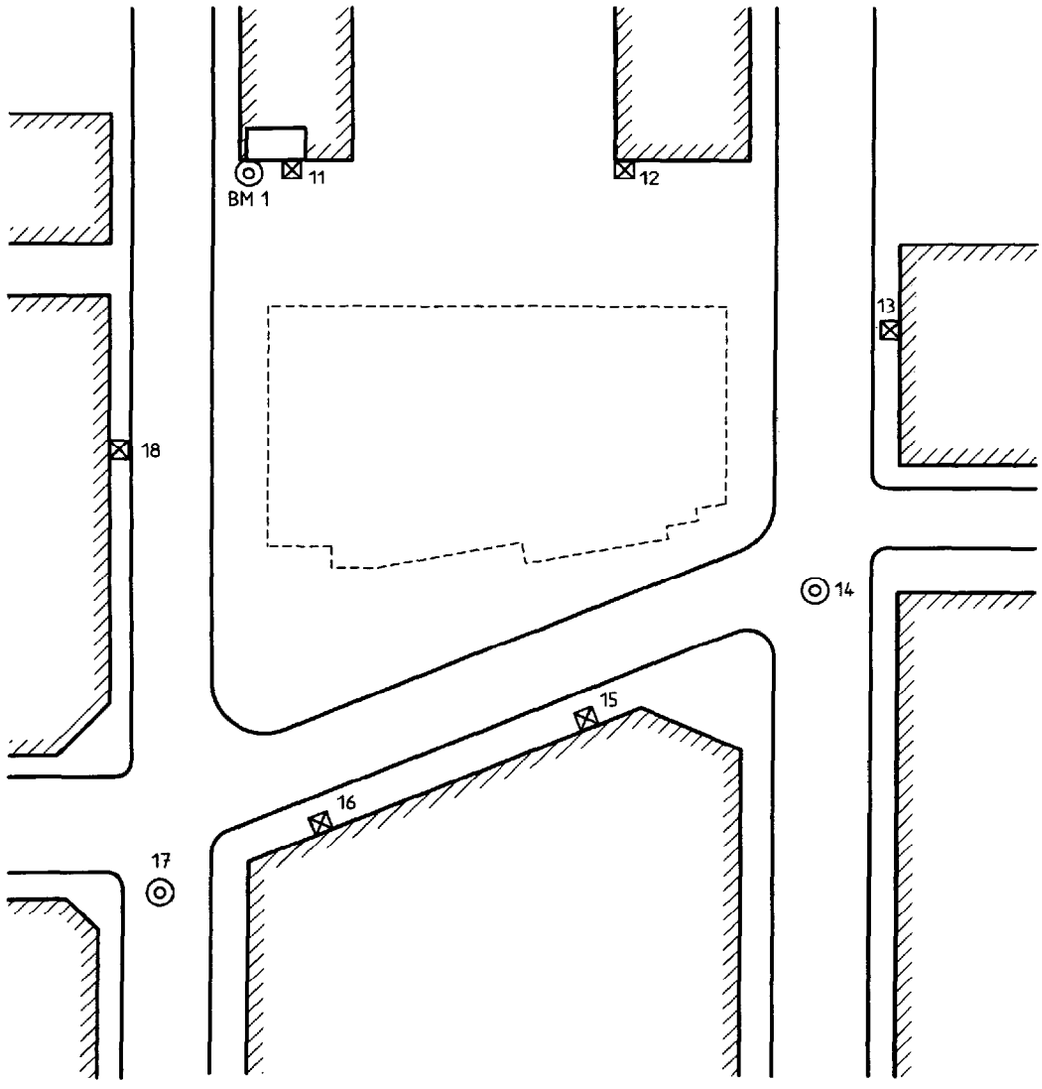
Figure A.21 shows a coordinated system with the following features:

a) a coordinate system, orientated on the main axes of the building;

b) the building is dimensioned in such a way that the coordinates in the local system of parts of the building are readily accessible;

c) use of the method of free station points.

This alternative (figure A.21) provides greater flexibility, and its advantages increase with increases in the size and complexity of the building.



NOTES

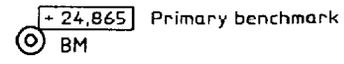
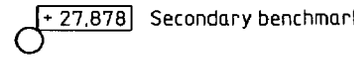
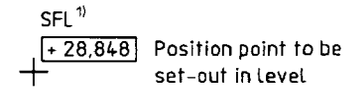
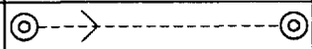
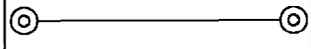
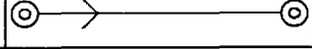
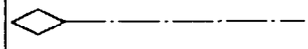
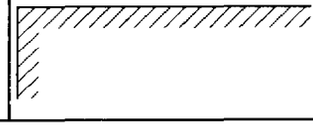
1 BM 1 is an existing benchmark.

2 Primary points numbers 14 and 17 are existing municipal measuring stations; primary points numbers 11, 12, 13, 15, 16 and 18 are specially established elevated targets.

3 For symbols, see table A.2.

Figure A.21 — Example of a setting-out plan (coordinated system)

Table A.2 — Symbols used in figures A.20 and A.21: Coordinate stations and targets

Triangulation points		Connecting point with site system	
		Other triangulation point	
Primary points		At ground level	EXAMPLE 
		Elevated targets	
Secondary points		Inside or outside the building	EXAMPLE 
		Intended for plumbing	
Position points		Point at ground or floor level	EXAMPLE 
Primary line		Direction	
		Distance	
		Direction and distance	
Secondary line			
Position line			
Outline of existing building			

1) SFL = structural floor level

Annex B
(informative)

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[9] ISO 8322-5:1991, *Building construction — Measuring instruments — Procedures for determining accuracy in use — Part 5: Optical plumbing instruments.*

[10] ISO 8322-6:1991, *Building construction — Measuring instruments — Procedures for determining accuracy in use — Part 6: Laser instruments.*

[10] ISO 8322-7:1991, *Building construction — Measuring instruments — Procedures for determining accuracy in use — Part 7: Instruments when used for setting-out.*

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ICS 91.200

Descriptors: buildings, building sites, dimensional measurements, measuring techniques.

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