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Building construction — Measuring instruments — Procedures for determining accuracy in use —

Part 10:
Difference between non-glass reflectors and electronic distance-measuring prisms (traditional glass prisms) for distances up to 150 m

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Construction immobilière — Instruments de mesure — Procédures de détermination de l'exactitude d'utilisation —

Partie 10: Différence entre les réflecteurs constitués de matériaux autres que le verre et les prismes traditionnels en verre des appareils de mesure de distances jusqu'à 150 m

Reference number
ISO 8322-10:1995(E)

Contents

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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.

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International Standard ISO 8322-10 was prepared by Technical Committee ISO/TC 59, *Building construction*, Subcommittee SC 4, *Dimensional tolerances and measurement*.

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/iso-8322-10-1995

ISO 8322 consists of the following parts, under the general title *Building construction — Measuring instruments — Procedures for determining accuracy in use*:

- — *Part 1: Theory*
- — *Part 2: Measuring tapes*
- — *Part 3: Optical levelling instruments*
- — *Part 4: Theodolites*
- — *Part 5: Optical plumbing instruments*
- — *Part 6: Laser instruments*
- — *Part 7: Instruments when used for setting out*
- — *Part 8: Electronic distance-measuring instruments up to 150 m*
- — *Part 10: Difference between non-glass reflectors and electronic distance-measuring prisms (traditional glass prisms) for distances up to 150 m*

Introduction

Modern building site survey techniques often require a relatively large number of electronic distance-measuring (EDM) prisms arranged around the site. Some of these prisms will be centred over ground stations, while others are needed as permanent targets, often in elevated positions (e.g. on buildings).

Figure 1 in ISO 4463-1:1989, *Measurement methods for building — Setting-out and measurement — Part 1: Planning and organization, measuring procedures, acceptance criteria*, might serve as an example of measuring systems on a site where both ground stations and elevated targets are used often simultaneously.

To equip all these reference points with traditional EDM prisms of glass would involve considerable costs, for purchase, recentring in inaccessible locations, and security. In order to reduce such costs, reflectors of materials other than glass (e.g. plastic) have been found to be attractive and suitable alternatives to traditional EDM prisms.

At the same time, one has to be aware of the fact that these non-glass reflectors are as a rule not designed for duties within land surveying but for many other possible purposes (e.g. in different technical fields).

A consequence of this is that the question arises as to whether such alternatives might serve as permanent EDM targets on sites. In other words, are EDM-measured distances to non-glass reflectors of the same accuracy as those measured to traditional glass prisms? Site surveyors should be able to find the answer to this question by applying a suitable test procedure.

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Building construction — Measuring instruments — Procedures for determining accuracy in use —

Part 10:
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1 Scope

This part of ISO 8322 specifies test procedures to be adopted when determining the accuracy in use of the difference between non-glass reflectors and traditional electronic distance-measuring (EDM) prisms of glass used in building construction for distances up to 150 m. This part of ISO 8322 applies in the first place to those building sites where the measuring system for setting-out and compliance combines EDM distance measurements to traditional glass prisms with those measured to non-glass reflectors.

When non-glass reflectors are used for the whole measuring procedure, ISO 8322-8 applies.

This part of ISO 8322 applies only to those types of EDM instruments measuring to a prism or reflector and used for surveying, setting-out, control, compliance measurements and when collecting accuracy data in building. EDM instruments measuring distances without the aid of a reflector or prism (so called "Impulse EDM") are not dealt with in this part of ISO 8322.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 8322. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8322 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8322-8:1992, *Building construction — Measuring instruments — Procedures for determining accuracy in use — Part 8: Electronic distance-measuring instruments up to 150 m.*

3 General requirements

The plastic reflectors to be used for these purposes should be resistant against environmental influences throughout the expected period of use. They can be fixed on target plates or range rods. If the reflectors can be rotated about their centres, the length measured shall not be significantly affected by such rotation.

4 Procedure

The selected non-glass reflector and the EDM glass prism shall be positioned by constrained centring. Measurements towards these targets shall be carried out over one or more distances similar to those to be measured on site. For one distance, a series of 10 measurements shall be made to the EDM prism and 10 to the non-glass reflector, changing after each observation.

The difference between the means of the observations to the EDM prism and those to the non-glass reflector is the additive correction valid for that particular distance.

An example of the observations over one distance is given in table 1-A.

Since non-glass reflectors are very often fixed permanently and therefore cannot be turned into alignment like prisms of the standard type, errors can arise caused by misalignment and due to too large an angle of incidence (see figure 1). It is therefore recommended that, after the series, the non-glass reflector should be turned around its axis (horizontally and vertically) in order to determine how far it can be turned from the orthogonal alignment position without significantly influencing the measuring result to the orthogonal alignment position.

In order to be able to investigate possible influences of the environment on the reflectors in use, observations may be repeated periodically from certain selected positions.

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5 Calculations

A complete example of the analysis is given in table 1-A using the measurements given in columns 2 and 6.

5.1 Calculate the arithmetic mean $\bar{x}$ (column 3) of the measurements to the EDM prism in column 2.

For example, 23,460 m.

5.2 Calculate the difference (residuals) of each value from the arithmetic mean (column 4).

For example, see No. 3: + 1 mm.

NOTE 1 As a check, the sum of the differences should be zero or close to it.

5.3 Calculate the squares of all values in column 4 and the sum of the squares in column 5.

For example, see No. 1: $(+3\ \text{mm})^2 = 9\ \text{mm}^2$

The sum of the squares = $36\ \text{mm}^2$

5.4 Calculate the standard deviation s_1 for the measurements to the EDM prism as the square root of the sum of squares (column 5) divided by the number of observations minus 1.

For example,

$$s_1 \sqrt{\frac{36}{9}} = \sqrt{4} = 2\ \text{mm}$$

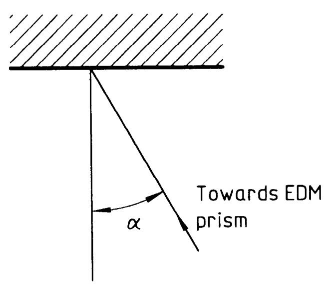
5.5 In the same way as in 5.1 to 5.4, calculate the standard deviation s_2 for the measurements to the non-glass reflector.

For example,

$$s_2 \sqrt{\frac{68}{9}} = \sqrt{7,6} = 2,8\ \text{mm}$$

5.6 Indicate the angle of incidence during the test (see figure 1).

5.7 If s_2 differs from s_1 by not more than twice s_1 (i.e. $s_2 \leqslant 2s_1$), the plastic reflector can be accepted for the intended task.



NOTE — Errors can arise due to large angles of incidence. Report this value in the field observation sheet.

Figure 1

5.8 The difference between the means of the measurements to the EDM prism and the non-glass reflector is the additive correction to the non-glass reflector to be used.

For example,

$$23{,}460 \text{ m} - 23{,}493 \text{ m} = -\,0{,}033 \text{ m}$$

$$= \text{additive correction}$$

NOTE 2 The procedure may be repeated for other distances as well, in order to investigate accuracies in use for those distances.

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Table 1-A — Example of field observations and calculation

Date:
Location:
Observer:
Instrument:
Measuring conditions:

Glass prism:
Non-glass reflector:

No.	Measurement to glass prism				Measurement to non-glass reflector			
	Value x m	**Mean** $\bar{x}$ m	**Deviation** $v = x - \bar{x}$ mm	v^2 mm^2	**Value** x m	**Mean** $\bar{x}$ m	**Deviation** $v = x - \bar{x}$ mm	v^2 mm^2
1	2	3	4	5	6	7	8	9
1	23,463		+ 3	9	23,495		+ 2	4
2	23,458		− 2	4	23,491		− 2	4
3	23,461		+ 1	1	23,496		+ 3	9
4	23,461		+ 1	1	23,497		+ 4	16
5	23,458	23,460	− 2	4	23,490	23,493	− 3	9
6	23,462		+ 2	4	23,492		− 1	1
7	23,459		− 1	1	23,495		+ 2	4
8	23,462		+ 2	4	23,491		− 2	4
9	23,458		− 2	4	23,494		+ 1	1
10	23,458		− 2	4	23,489		− 4	16
Σx	234,600	23,460	0	36	234,930	23,493	0	68

Glass prism:

$$\bar{x} = \frac{234,600}{10} = 23,460 \text{ m}$$

$$s_1 \sqrt{\frac{36}{9}} = \sqrt{4} \text{ mm}$$

$$s_1 = 2 \text{ mm}$$

Non-glass reflector:

$$\bar{x} = \frac{234,930}{10} = 23,493 \text{ m}$$

$$s_2 \sqrt{\frac{68}{9}} = \sqrt{7,6} \text{ mm}$$

$$s_2 = 2,8 \text{ mm}$$

$$s_2 < 2 s_1$$

$$s_2 < 4 \text{ mm}$$

Additive correction: 23,460 m − 23,493 m = − 0,033 m

[Angle of incidence, $\alpha = 5$ gon]

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Table 1-B — Field observations and calculation

Date:
Location:
Observer:
Instrument:
Measuring conditions:

Glass prism:
Non-glass reflector:

No.	Measurement to glass prism				Measurement to non-glass reflector			
	Value x m	Mean $\bar{x}$ m	Deviation $v = x - \bar{x}$ mm	v^2 mm^2	Value x m	Mean $\bar{x}$ m	Deviation $v = x - \bar{x}$ mm	v^2 mm^2
1	2	3	4	5	6	7	8	9
1 2 3 4 5 6 7 8 9 10								
Σx								

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ISO 8322-10:1995
https://standards.iteh.ai/catalog/standards/sist/ad896712-623b-41b3-a537-f02e8ea2aa11/iso-8322-10-1995

$\bar{x} = \frac{\Sigma x}{10}$ m

$s = \sqrt{\frac{(x - \bar{x})^2}{9}} = \sqrt{\frac{v^2}{9}}$ mm

$s_1 =$ mm
$s_1 =$ mm

$s_2 =$ mm
$s_2 =$ mm

Additive correction:

[Angle of incidence, $\alpha =$ gon]