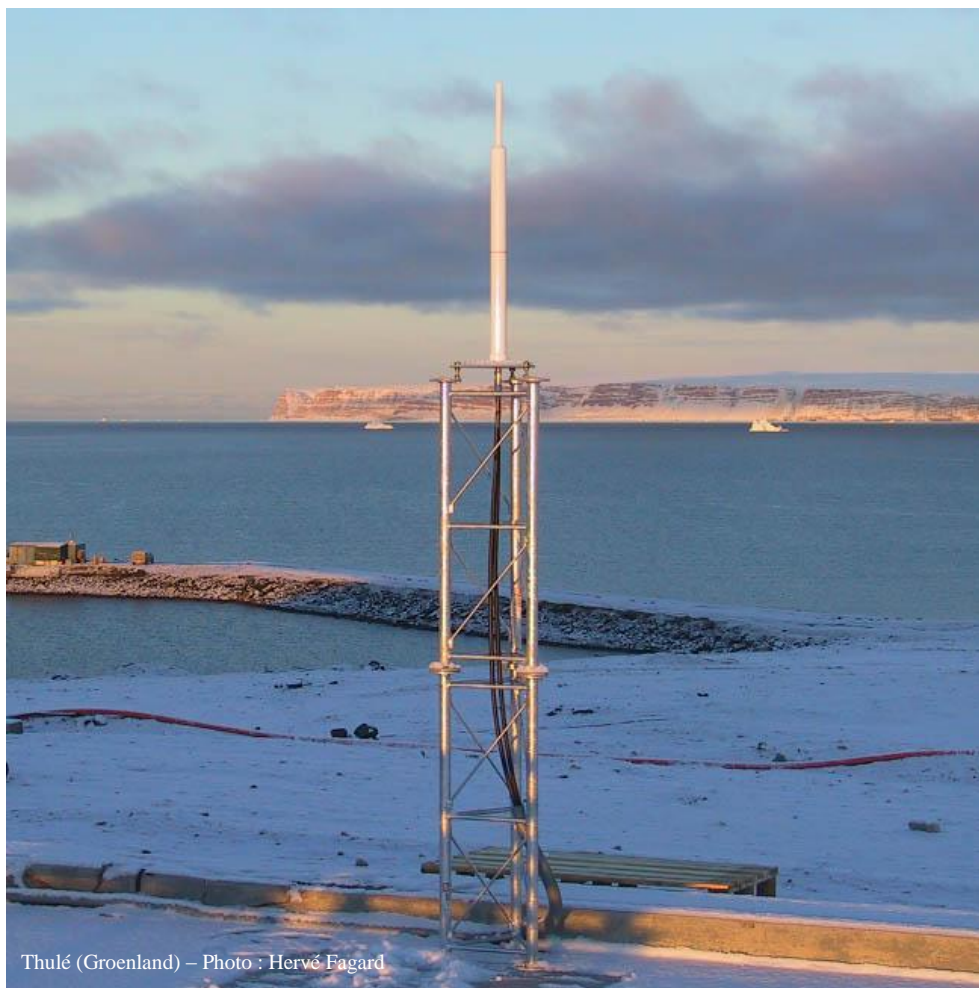


Jérôme Saunier

DORIS Site

Standard configurations



DIFFUSION OUVERTE

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Mots-clé

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Résumé

L'objet de ce document est de décrire les monumentations standard utilisées pour les antennes du réseau DORIS. Ce document rédigé en anglais, est une annexe du document écrit par le CNES sous la référence : CO-SP-R-EA-15226-CN "System Requirements for Management of the Station Network". Le présent document dont l'IGN a la charge et la responsabilité, y est mentionné au paragraphe 7.3.3 (EX.I_360).

Matériel

Système d'exploitation

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1 Context, subject and scope of the document

The purpose of this document is to describe the standard configurations compliant with the DORIS system requirements applicable to the management of the DORIS station network.

This document is an appendix of the CNES document referenced CO-SP-R-EA-15226-CN "System Requirements for Management of the Station Network", mentioned in paragraph 7.3.3 (EX.I_360). IGN writes and updates this appendix because this matter comes within its remit.

This document applies to the DORIS station network for all DORIS instruments currently being developed or in use.

1.1 Presentation

During the DORIS network deployment, several monuments have been designed according to local configuration (environment, soil structure, equipment availability...). In order to control and qualify the network configuration, the working party "Groupe Mission DORIS" decided at the end of 2009 to reduce the number of monument types by specifying three standards.

These three standard monuments are compliant with all the DORIS system requirements (stability, RF environment...) and must fit in all cases.

Depending on the layout of the premises and how the antenna environment looks like, a standard monument is selected and proposed by IGN who knows the lie of the land.

Distinctive characteristics of each standard monument are detailed hereafter.

1.2 Organization

This document is organized into five parts as follows:

Part 1 presents the content of this document,

Part 2 draws up monumentation requirements and deals with the geodetic aspects,

Part 3 comes up with recommendations about concrete bases construction according to the soil structure,

Part 4 gives basic rules to be observed for installing and fixing into concrete,

Part 5 details the three standard monuments in the shape of log sheet.

2 Requirements

Besides being easy to assembly and easy to implement, any monument should meet some system and geodetic requirements.

2.1 System requirements

2.1.1 Reference point – Antenna verticality

The reference point of the antenna is the point where each DORIS observation refers to. The reference point is defined as intersection of the vertical axis of the antenna (in theory containing the 2GHz phase center) and the painted red ring (in theory containing the 400MHz phase center).

It means that the antenna verticality must be adjusted with accuracy using leveling screws and optical topographic measuring instruments.

2.1.2 Antenna height

In order to reduce signal power attenuation and multi-path effect with the floor, CNES demonstrated that the antenna base height with respect to the floor must be higher than 1.85m.

However, for security reasons and survey convenience, monuments higher than 2m should be avoided.

2.1.3 Resistance

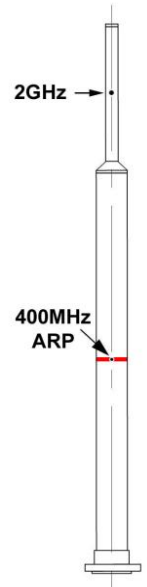
Considering DORIS stations longevity, materials must be as resistant as possible with regard to solidity and corrosion. Combinations of incompatible metals are to be avoided in the monumentation (see EX. I_240).

2.2 Geodetic requirements

The antenna reference point (see above) is a geodetic point. By definition, its installation must comply with general specifications of geodetic control surveys. Therefore, all operation upon the antenna is undertaken by surveyors taking necessary precautions (IGN staff in most cases).

2.2.1 Equipment

In order to tie the antenna reference point with a physical point, a marker is set up under the antenna. This marker is essential to measure antenna offset after replacing or moving. The marker (generally a domed brass mark) is embedded in concrete as close as possible to the vertical line containing the antenna reference point. This marker is the geodetic print of DORIS, considered as a witness mark.



2.2.2 Visibility

Markers must be within sight of theodolite; that is to say at head height. Therefore, top of concrete pillars should go no further than 1,50 m above ground. In the same way: no obstructions all around markers.

2.2.3 Stability

In order to have significant information about tectonic plates movements, monuments and antenna supports must be very stable and foundations must be very well anchored to the bedrock.

3 Concrete base

The concrete base is the connection element between the subsoil and the antenna support. Stability is a very important selection criterion.

3.1 Existing construction

Opportunities for setting up antennas on existing construction are always considered in accordance with the requirements.

3.1.1 Building

Terrace roofs are sometimes the only option to get a clear view of the sky with acceptable obstructions. In that case, the antenna should be installed on bearing wall buildings or near support structures. Small footprint and one-storied buildings with solid foundations on bedrock are preferable to bigger and higher constructions.

3.1.2 Concrete block or pillar

Existing concrete block or pillar on site can be used if it meets the requirements detailed below.

3.2 New construction

If need be, a concrete base has to be built in order to take the antenna support. After giving some guiding principles, three types of foundations depending on soil structure are hereafter presented in order of preference.

3.2.1 Guiding principles

All construction must respect the following specifications:

- High strength, reinforced and vibrated concrete is required.
- Steel reinforcement rebars diameter 1 cm are required.
- After excavation and construction, soil is backfilled and compacted.
- Curing time for concrete must be respected

These specifications should be submitted to local contractors at the time of the call for tenders. These specifications could be supplemented by usual or local measures on the contractor's advice; in particular, curing time has to be determined by the contractor.

Nota: the choice of a local contractor able to duly carry out the construction is crucial but, as DORIS network is set up in many remote areas, we have to make do with the existing local skills.

After geological data studies (if available) and a field reconnaissance looking for possible exposed bedrock, the antenna location is determined. The design and the depth of the base construction are depending of the soil structure. Anyway, it is advisable to reach the hard stratum.

Sizes (height and width) of the concrete base (pedestal or pillar) are defined in accordance with the antenna support type. However, top of concrete base should go no further than 1,50 m above ground for the reasons set out in paragraphs 2.1.2. and 2.2.2.

3.2.2 Solid bedrock

As we want maximum stability, anchor the mount foundation in solid bedrock is the best thing to do if possible.

The plan is to drill down around half meter (20 inches) with a masonry bit in order to embed four rods reinforcing the pillar. Horizontal rebars are added and wired with vertical ones in order to get a mesh.

3.2.3 Hard soil

Hard soil is defined as earth not so easy to dig out, as clayey soil or soil-rock mixtures.

When this kind of soil is reached, a large (~ 1 meter) reinforced concrete slab is poured in order to make a stable foundation for the pillar.

Dimensions are adjusted according to soil hardness.

3.2.4 Soft soil

Soft soil is obviously less suitable for stability. Nevertheless, the solution consists of enlarging the concrete slab under the pillar in order to function as a stratum.

A 2 meters sided half-meter high reinforced concrete slab has to be poured at the base of the pillar, at a depth of at least one meter. The iron framework must be a single block (slab + pillar).

To reinforce the whole monument, a long pipe - 15 cm diameter steel casing, 10 m long – can be driven on the pillar axis into the soil as deep as possible.

4 Antenna support installation

Terminology: The antenna support is the metallic structure holding the DORIS antenna in the space between the concrete base and the antenna bottom.

4.1 Components

Antenna support components are detailed in paragraph 5 where the three standard monuments are described.

We can differentiate three distinct antenna support parts:

- Foot: Part allowing fixation into concrete pedestal
- Body: Part between foot and head
- Head: Part where the antenna is fixed

The antenna support head is always made of summital triangular plate equipped with leveling screws in order to adjust the antenna verticality. Each standard monument has a dedicated triangular plate (different sizes: See appendixes)

4.2 Assembly

To prevent any transport problem, antenna supports are shipped in kit form. The on-site assembly has to be done in inverse order beware of connection between parts. Self-blocking nuts or blocking washer are used for tightening and final setting. Mounting instructions are available at IGN.

4.3 Fastening

The fastening of the antenna support into concrete is carried out according to standard building works rules. Expansion anchors or threaded rods embedded with chemical embedding (epoxy) can either be used.

In the case of expansion anchors, space between fixing points into concrete are given by manufacturer specifications (compression or tension zone) and must be strictly respected. Note that adding fixing points on antenna support feet does not make the monument stronger but easier to be pulled up.

Size of threaded rods depends of the height and the weight of the antenna support.

4.4 Security

Antenna support setting often requests redoubled vigilance in terms of safety. Current safety regulations must be observed during installation, in particular: Fall prevention, eye and ear protection.

4.5 Verticality and centering adjustment

The antenna must be installed so that its two phase centers are on a perfect vertical line. By playing with the support slope and the leveling screws under the summital triangular plate, the verticality and centering are adjusted, using two theodolites positioned in two perpendicular directions.

4.6 Survey

The antenna eccentricities (North, East and Up) with respect to the ground mark are measured using two theodolite locations on the North-South and East-West directions.

These land surveys procedures are detailed in IGN internal specifications.

5 Specifications

The three standard monument characteristics are hereafter detailed in the shape of log sheet.

5.1 Monument type I

Description: Half-meter high; 17cm sided metal tower installed on load-bearing wall

Base type: top of a load-bearing pillar or at the corner of two load-bearing walls of small building (one storied).

Base requirements: 23cm width

Marker: domed brass mark 12 mm diameter

Antenna support: stainless steel triangular plate type I (see appendix 1)

Foot part: steel triangular plate 20/10 with 3 holes

Manufacturer: Etablissement Normand, F-62110 HENIN BEAUMONT, France

Assets: small footprint, easy shipping, easy setting.

Disadvantage: galvanized but not corrosion-resistant steel, low-rise support (loss of stability if higher)

Preferential use: low-rise building with narrow walls, non-corrosive environment.



Components:

Item	Dimensions	Matter	Function	Number
Normand element	Triangular section of 21 cm; 50 cm high	Galvanized steel	Main part	1
Triangular plate type I	See scheme appendix 1	Inox 316L	Head part	1
Bolt	M10x60	Inox A4	Plate fixation	3
Chemical anchor	M10	Inox A4	Element fixation	3
Nut	Diam. 10	Inox A4	Mounting	15
Flat washer	Diam. 10	Inox	Mounting	9
Lock washer	Diam. 10	Inox	Mounting	9

NB: For stability reasons, it is not recommended to add a second Normand element.

5.2 Monument type II

Description: Custom made stainless steel tripod installed on concrete pillar

Base type: pillar 1,5 m high above ground

Base requirements: 40 cm width

Marker: domed brass mark 12 mm diameter

Antenna support: stainless steel triangular plate type II (see appendix 2)

Foot part: stainless steel disk with 3 holes (see appendix 5)

Manufacturer: IGN workshop

Assets: custom made (adaptable on existing threaded rods), high corrosion resistance, stability, easy shipping, easy setting.

Disadvantage: maximum height 50 cm for stability reasons

Preferential use: corrosive environment, clear sky view



Components:

Item	Dimensions	Matter	Function	Number
Tripod	Variable (min. height: 40cm)	Inox passivated	Main part	1
Triangular plate type I	See scheme appendix 6.2	Inox 316L	Head part	1
Bolt	M10x60	Inox A4	Plate fixation	3
Chemical anchor	M10	Inox A4	Tripod fixation	3
Nut	Diam. 10	Inox A4	Mounting	21
Flat washer	Diam. 10	Inox	Mounting	9
Lock washer	Diam. 10	Inox	Mounting	9

NB: This monument type can also be used on load-bearing walls (see above)

5.3 Monument type III

Description: Very rigid steel tower installed on concrete block

Base type: concrete block (25 cm minimum above ground) or concrete slab

Base requirements: 60 cm sided minimum

Marker: domed brass mark 12 mm diameter

Antenna support: stainless steel triangular plate type III (see appendix 3)

Foot part: triangular tower base with 3 disks diam. 11cm

with 4 holes (see appendix 4)

Manufacturer: Etablissement Leclerc, 3 rue des Crocs, 77873 Montereau, France

Assets: higher monument, smaller pedestal.

Disadvantage: limited corrosion resistance, shipping, setting.

Preferential use: poor visibility



Components:

Item	Dimensions	Matter	Function	Number
Leclerc element	Triangular section of 32 cm; 1 m high	Galvanized steel ISO 1461	Main part	2
Triangular plate type III	See scheme appendix 6.3	Inox 316L	Head part	1
Bolt	M12x60	Inox A4	Plate fixation	3
Nut	Diam. 12	Inox A4	Plate fixation	12
Bolt	M12x30	Inox A4	Pylon assembly	12
Nut	Diam. 12	Inox A4	Pylon assembly	12
Expansion anchor	M10x90	Inox A4	Pylon fixation	3
Nut	Diam. 10	Inox A4	Pylon fixation	3
Flat washer	Diam. 10	Inox	Pylon fixation	3
Lock washer	Diam. 10	Inox	Pylon fixation	3
Flat washer	Diam. 12	Stainless steel	Mounting	18
Lock washer	Diam. 12	Stainless steel	Mounting	18

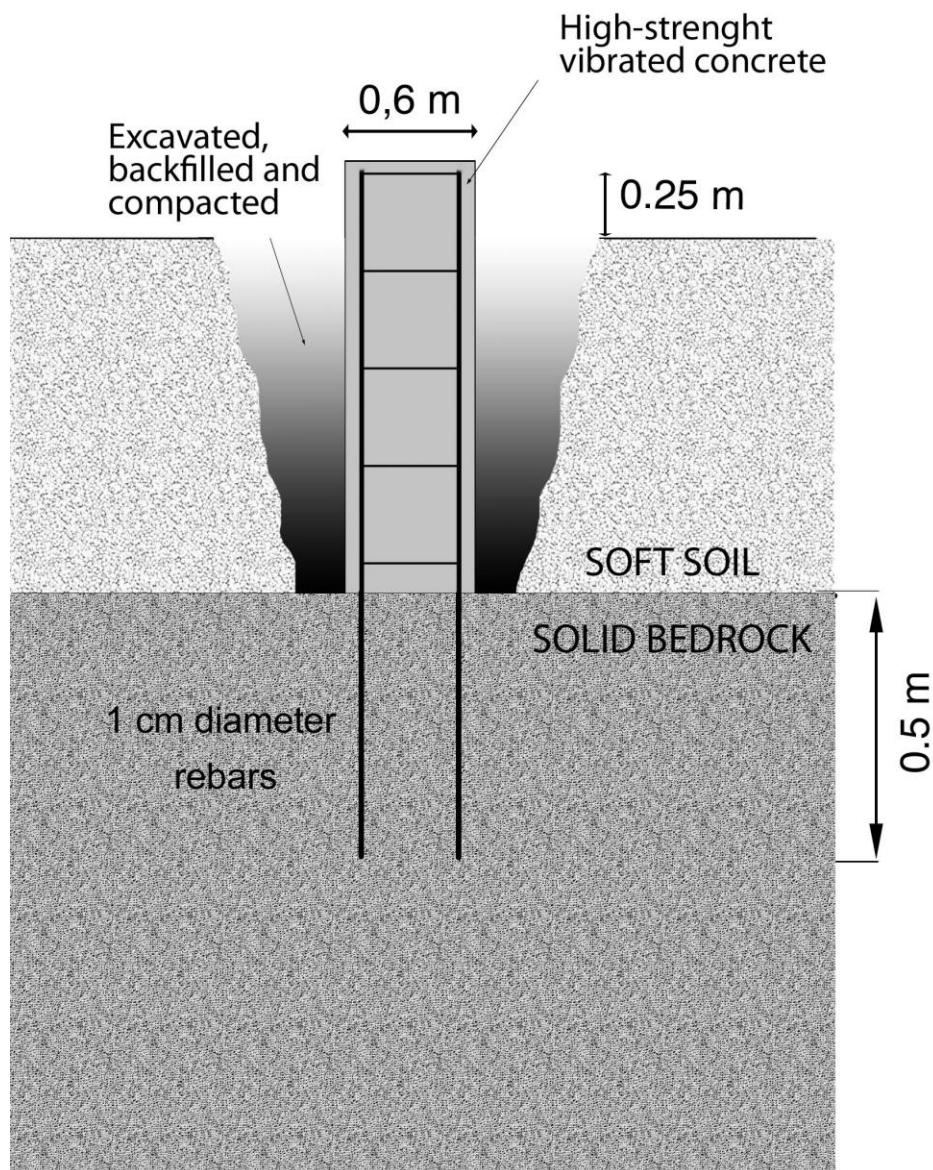
NB: This monument type can also be used on terrace roof of small building (one storied) and as an exception on wide and low concrete pillar.

6 Appendixes

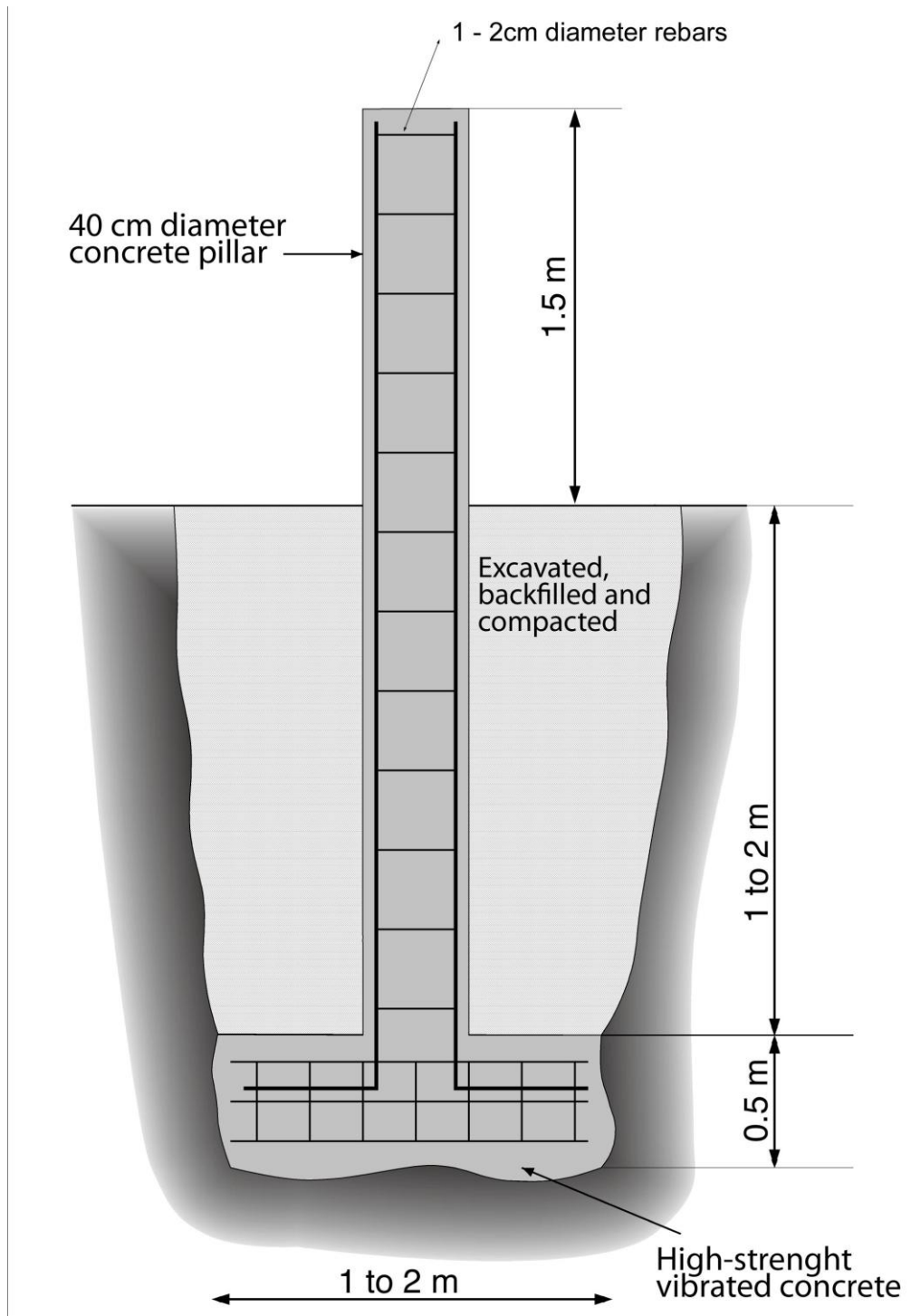
Warnings:

- Appendixes 1 to 3: the drawings are examples; sizes can change according to needs
- Appendixes 4 to 8: the mentioned scales on the drawings are not significant

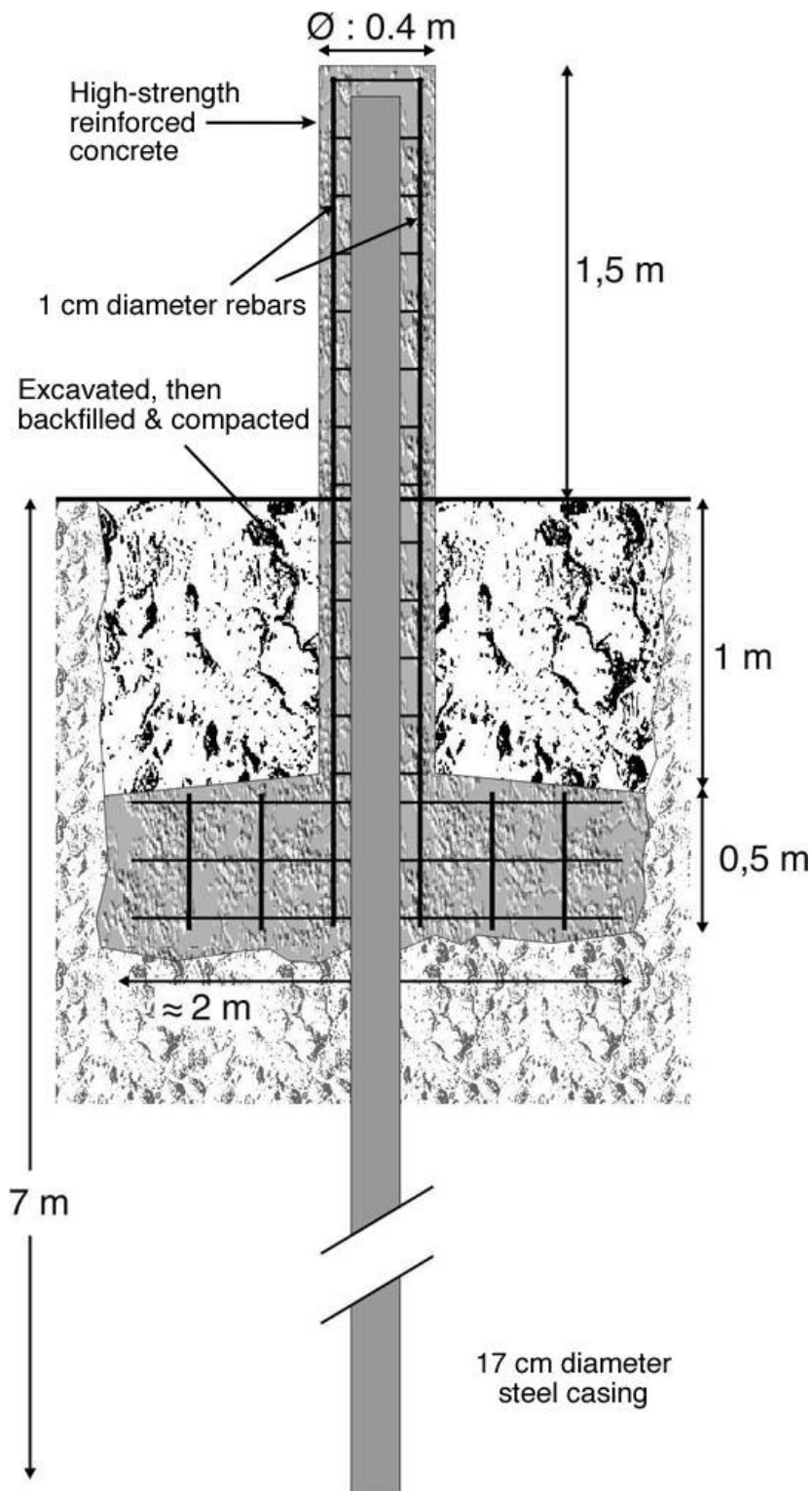
6.1 Appendix 1: Concrete base in the case of solid bedrock



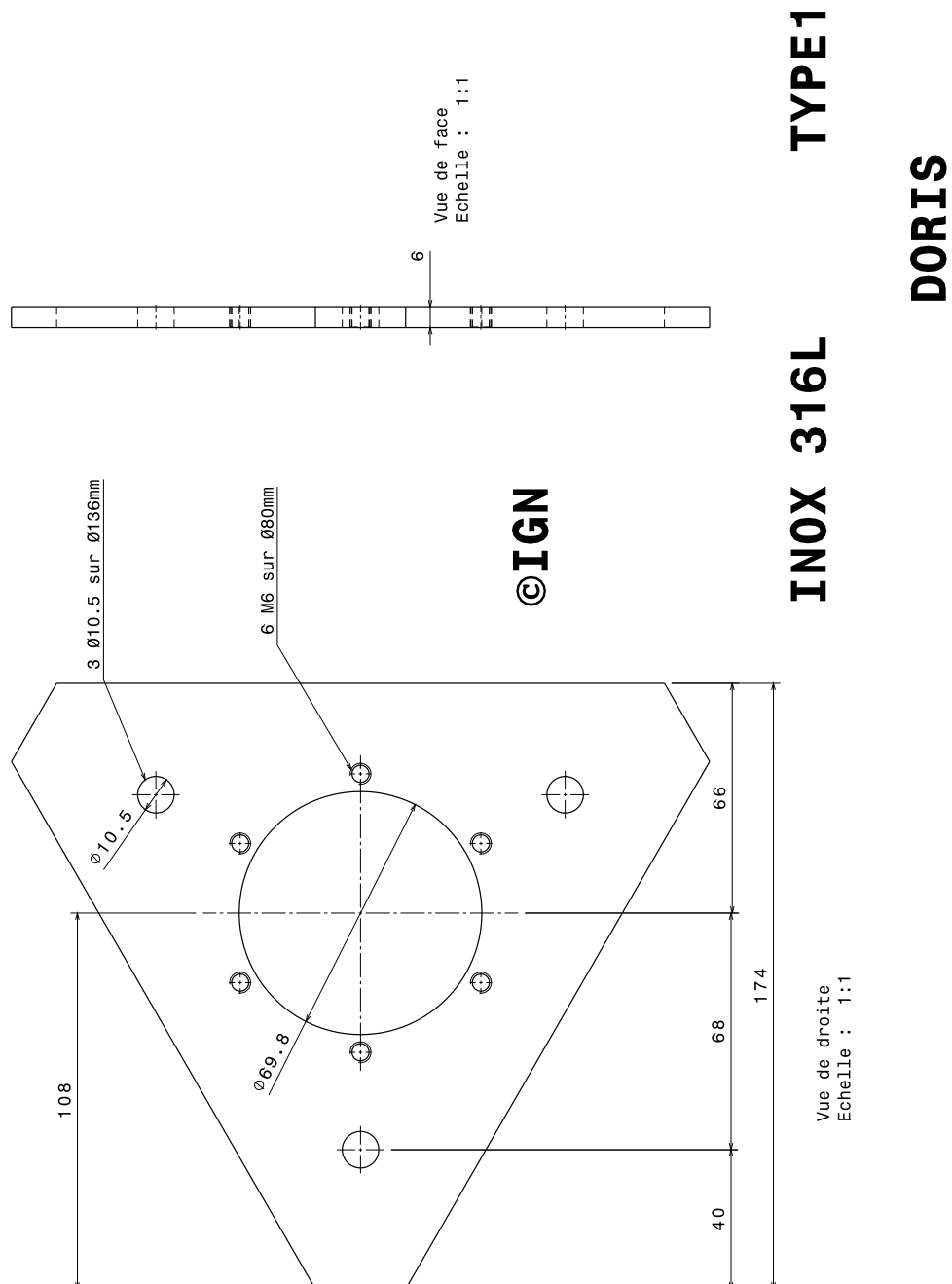
6.2 Appendix 2: Concrete base in the case of hard soil



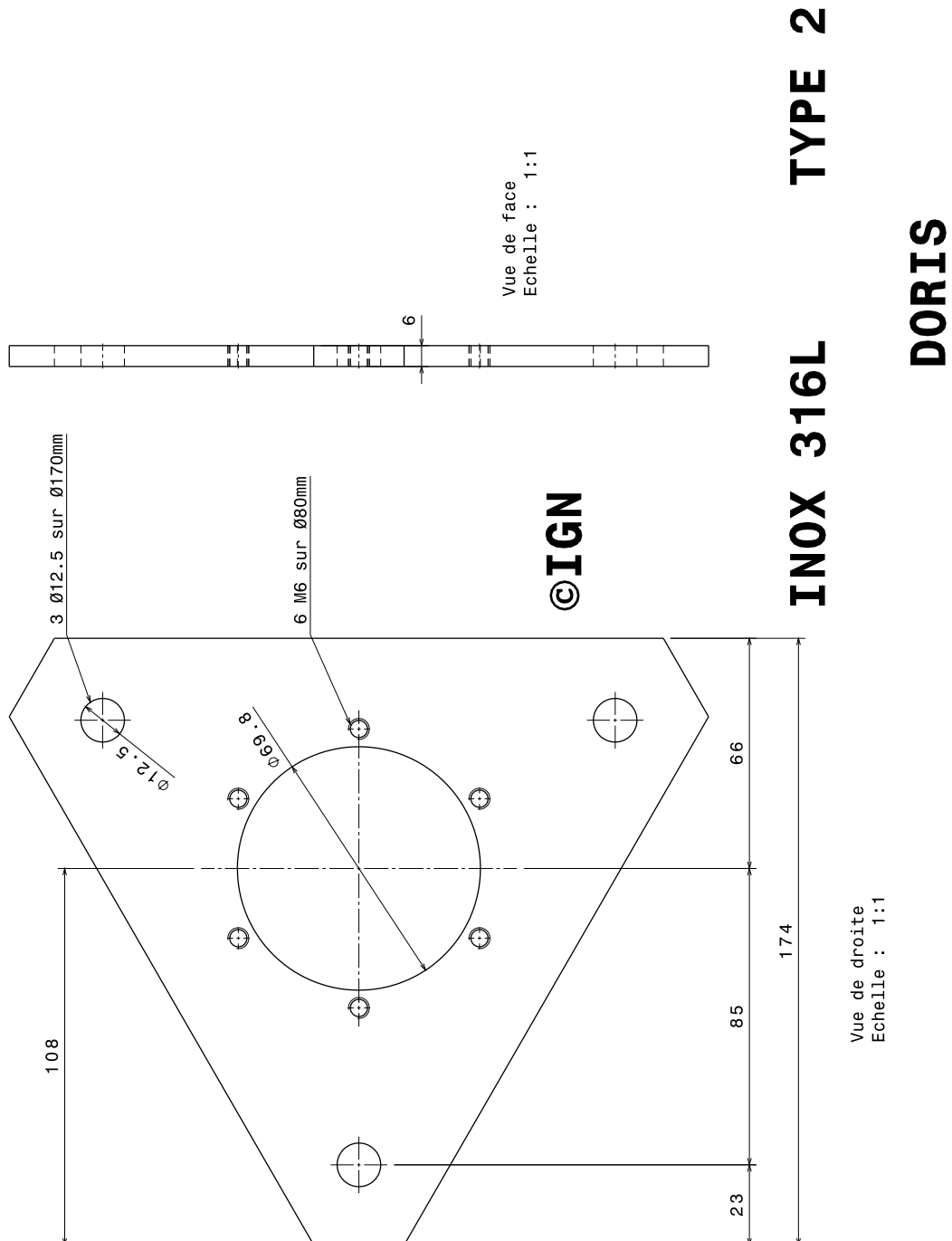
6.3 Appendix 3: Concrete base in the case of soft soil



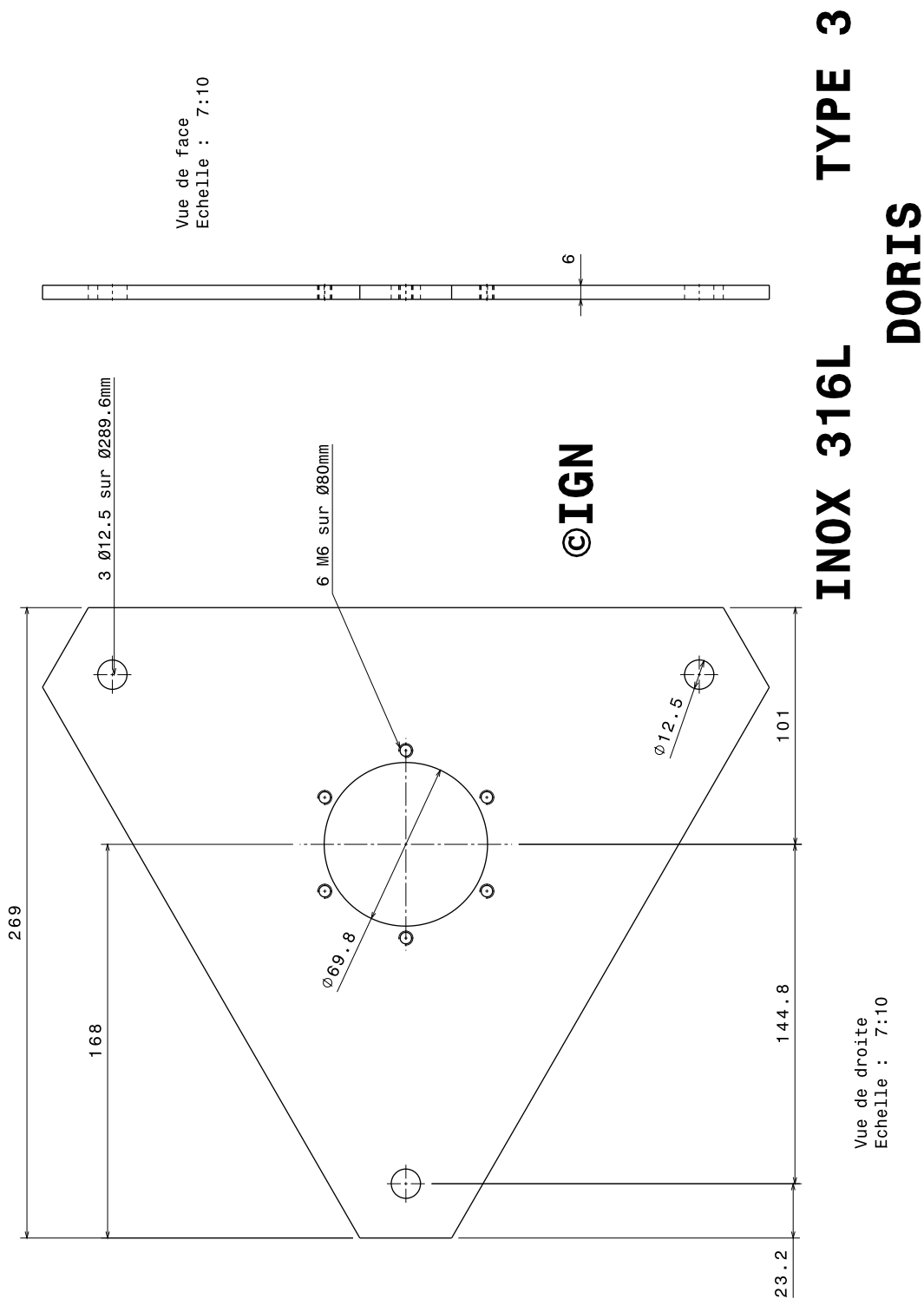
6.4 Appendix 4: Triangular plate type I



6.5 Appendix 5: Triangular plate type II



6.6 Appendix 6: Triangular plate type III



6.7 Appendix 7: Leclerc tower base

