INSTITUT NATIONAL DE L'INFORMATION GÉOGRAPHIQUE ET FORESTIÈRE

GNSS monumentation Standard configurations

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1 REQUIREMENTS

1.1 SYSTEM REQUIREMENTS

1.1.1 REFERENCE POINT – ANTENNA VERTICALITY

The permanent marker of the GNSS station reference and the antenna reference point where each GNSS observation refers to must be on the same vertical line.

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

1.1.2 RESISTANCE

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

1.2 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).

1.1.3 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 GNSS, considered as a witness mark.

1.1.4 VISIBILITY

Markers must be within sight of theodolite; that is to say at head height. Therefore, no obstructions all around markers.

1.1.5 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.

2 CONCRETE BASE

2.1 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.

2.2 NEW CONSTRUCTION

2.2.1 GUIDING PRINCIPLES

All construction must respect the following specifications:

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

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.

2.2.2 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.

2.2.3 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.

2.2.4 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.

3 ANTENNA SUPPORT INSTALLATION

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

3.1 COMPONENTS

Antenna support components are detailed in paragraph 5 where the standard monument 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.

3.2 ASSEMBLY

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

3.3 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.

3.4 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.

3.5 VERTICALITY AND CENTERING ADJUSTMENT

The antenna must be installed so that its reference point and its physical marker point 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 and a professional carriers laser deliver on outstanding 0,3mm centring accuracy.

3.6 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. A specific local precise survey can be done. These land surveys procedures are detailed in IGN internal specifications.

4 MONUMENT

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 (see appendix 4)

Foot part: triangular tower base with 3 disks diam. 11Cm with 4 holes (see appendix 5)

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

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 building.

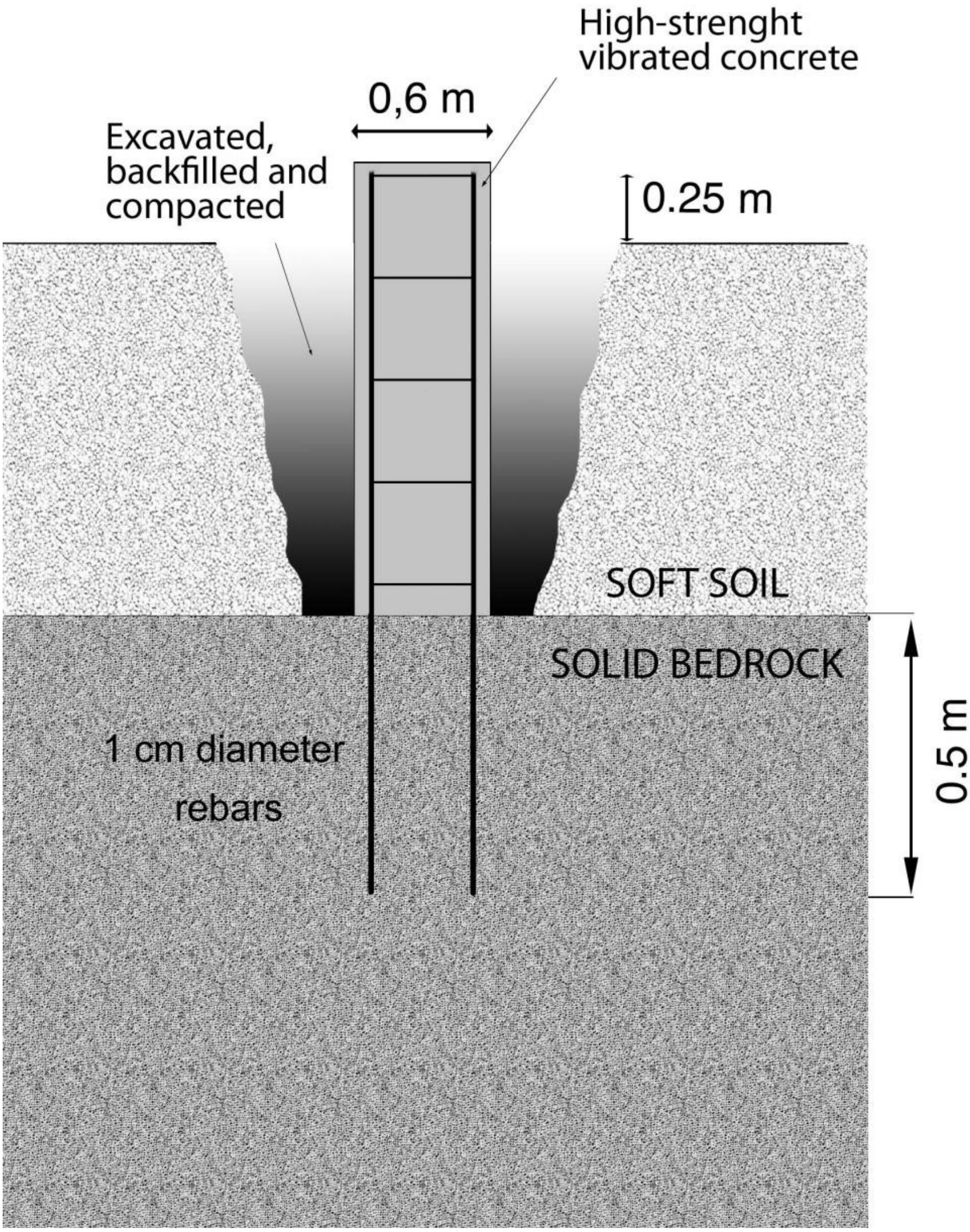
5 APPENDIXES

Warnings:

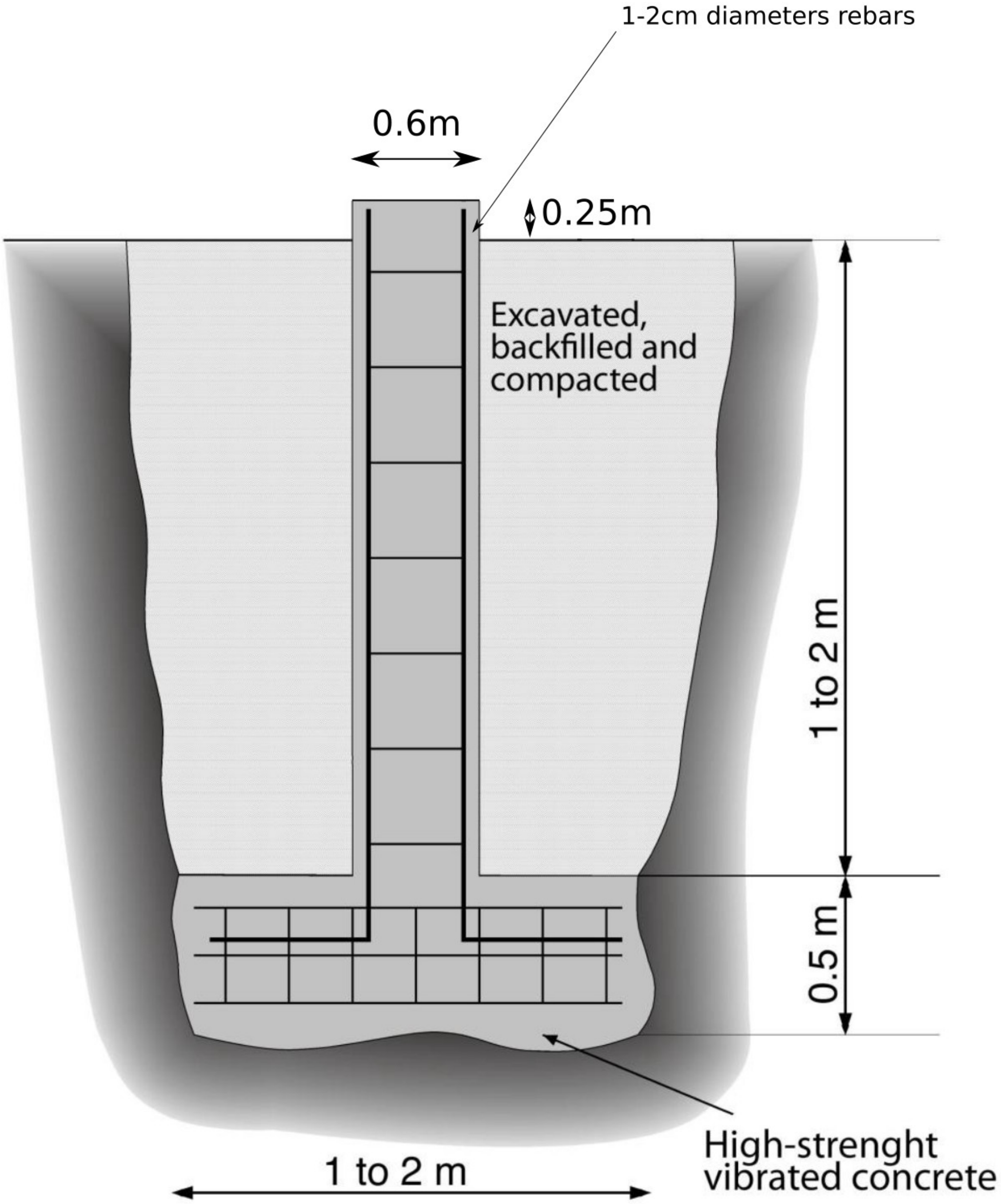
- Appendixes 1 to 3: the drawings are examples; sizes can change according to needs

- Appendixes 4 to 6: the mentioned scales on the drawings are not significant

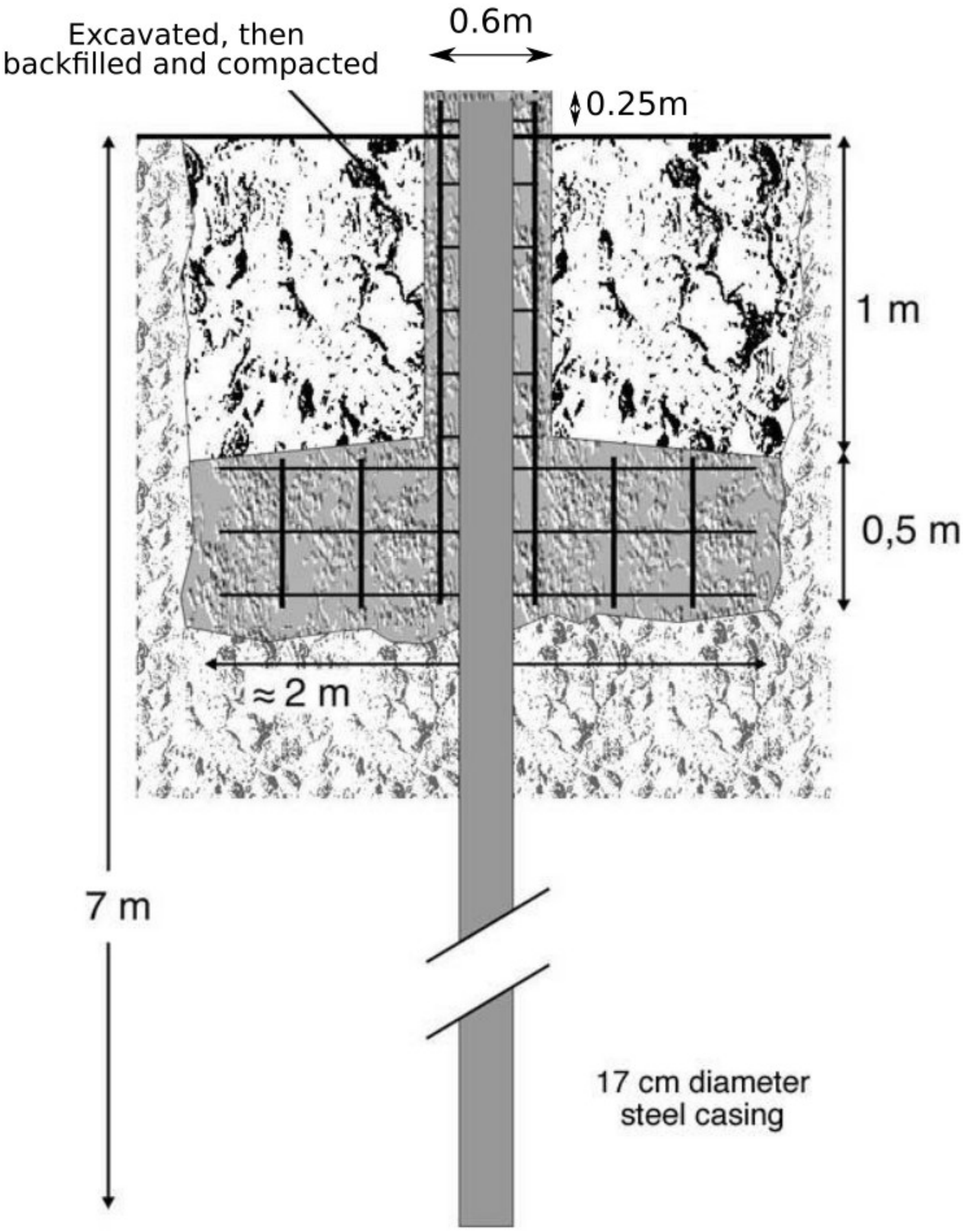
5.1 APPENDIX 1: CONCRETE BASE IN THE CASE OF SOLID BEDROCK



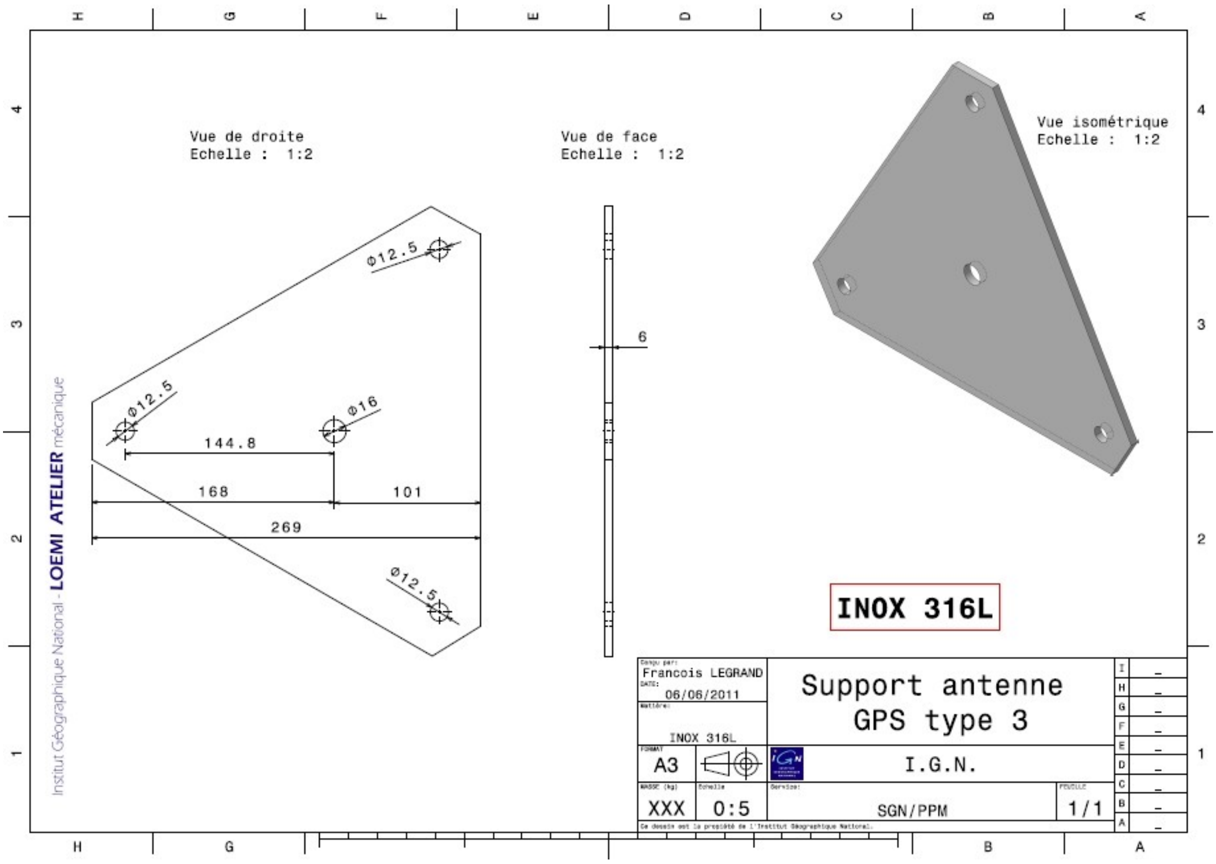
5.2 APPENDIX 2: CONCRETE BASE IN THE CASE OF HARD SOIL



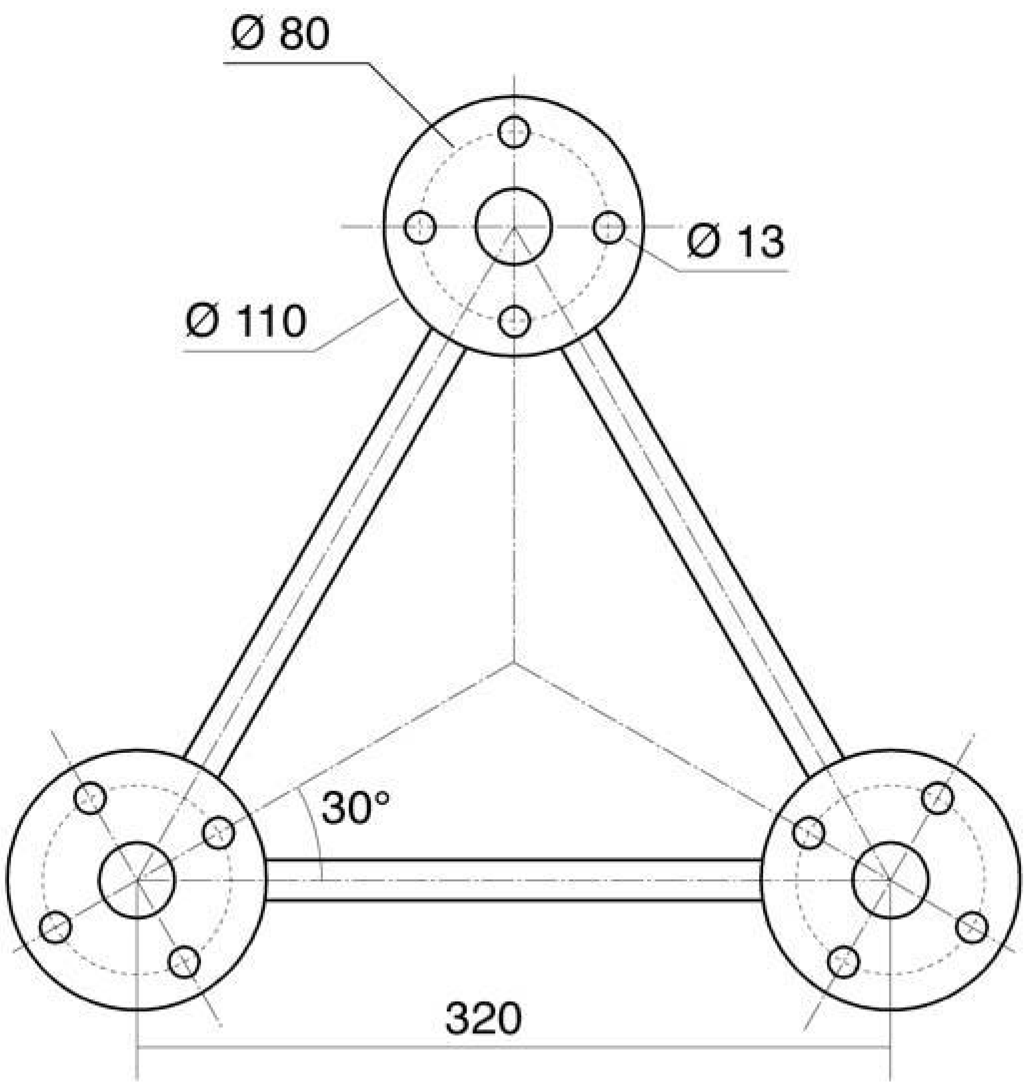
5.3 APPENDIX 3: CONCRETE BASE IN THE CASE OF SOFT SOIL



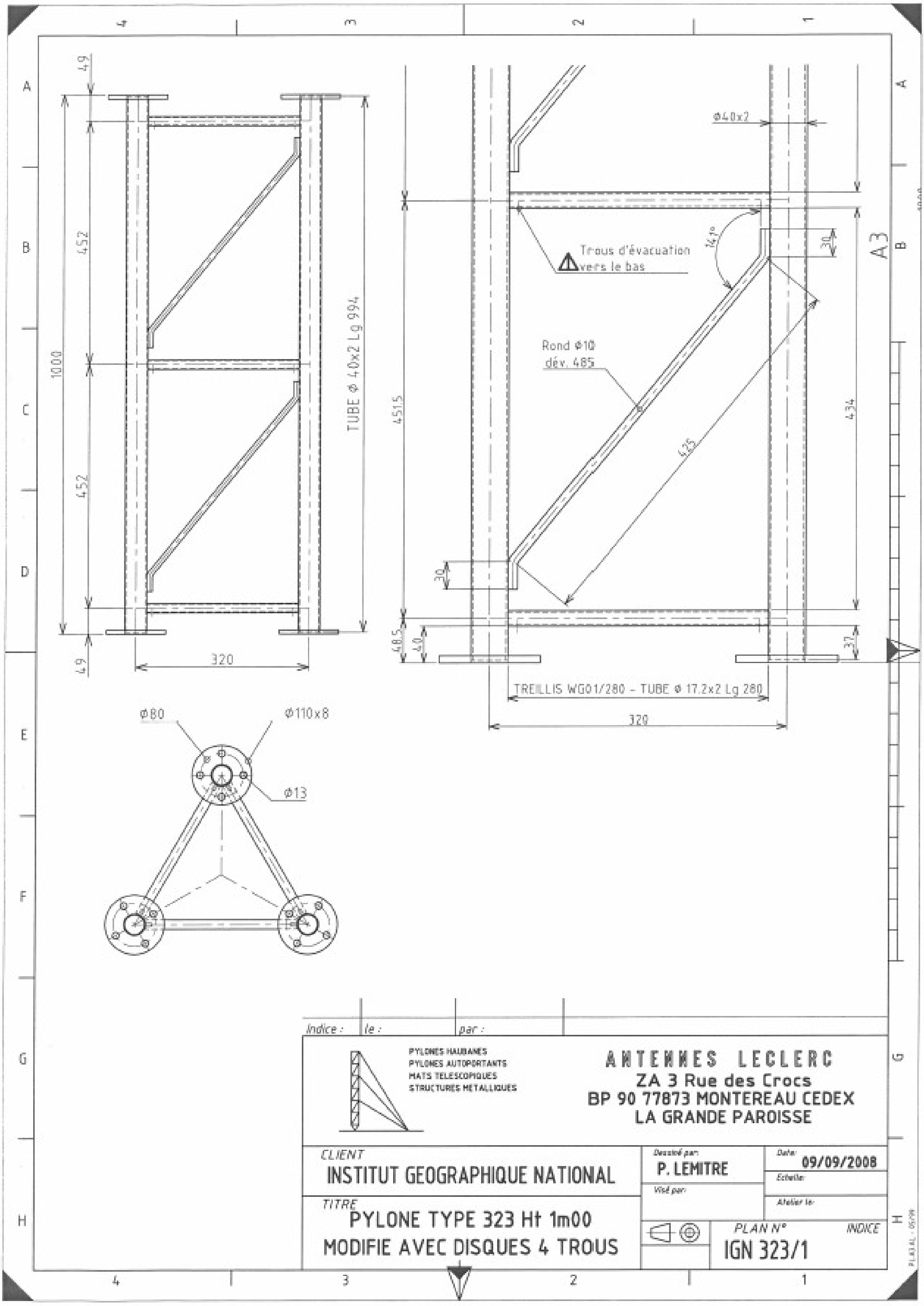
5.4 APPENDIX 4: TRIANGULAR PLATE



5.5 APPENDIX 5: LECLERC TOWER BASE



5.6 APPENDIX 6: LECLERC ELEMENT



1m element

5.7 APPENDIX 7: STUDY ON THE FORCES AT THE BASE OF THE 2 METER LECLERC PYLON

On a member	120 km/h	200 km/h
Edge effect	9,7 daN	27 daN
Lifting effect	137,2 daN	389,8 daN

Extract from a french study:

CALCUL DE L'EFFORT TRANCHANT ET DU MOMENT FLECHISSANT
POUR UN PYLONE AUTOPORTANT DE 2 METRES

HYPOTHESES DE CALCUL :

Région de vent : Région 6, Site Normal

Vitesse de vent extrême à 10 m du sol : 200 km/h

Pression de vent à 10 m du sol : 189.4 daN/m²

Charges sur le pylône : 0.1 m² à une hauteur de 2.5 m

Altitude de la base du pylône : sol

Coefficient dynamique : ß= 1.1

COMPOSITION DU PYLONE :

2 tronçons de section triangulaire entraxes 0.32 à 0.32 m

EFFORTS A LA BASE SOUS VENT EXTREME :

Effort tranchant : 81 daN

Moment fléchissant : 108 m.daN

MASSE DE L'ENSEMBLE : 26 kg

CALCUL DE L'EFFORT TRANCHANT ET DU MOMENT FLECHISSANT

POUR UN PYLONE AUTOPORTANT DE 2 METRES

HYPOTHESES DE CALCUL :

Région de vent : Région 6, Site Normal

Vitesse de vent extrême à 10 m du sol : 120 km/h

Pression de vent à 10 m du sol : 68 daN/m²

Charges sur le pylône : 0.1 m² à une hauteur de 2.5 m

Altitude de la base du pylône : sol

Coefficient dynamique : ß= 1.1

COMPOSITION DU PYLONE :

2 tronçons de section triangulaire entraxes 0.32 à 0.32 m

EFFORTS A LA BASE SOUS VENT EXTREME :

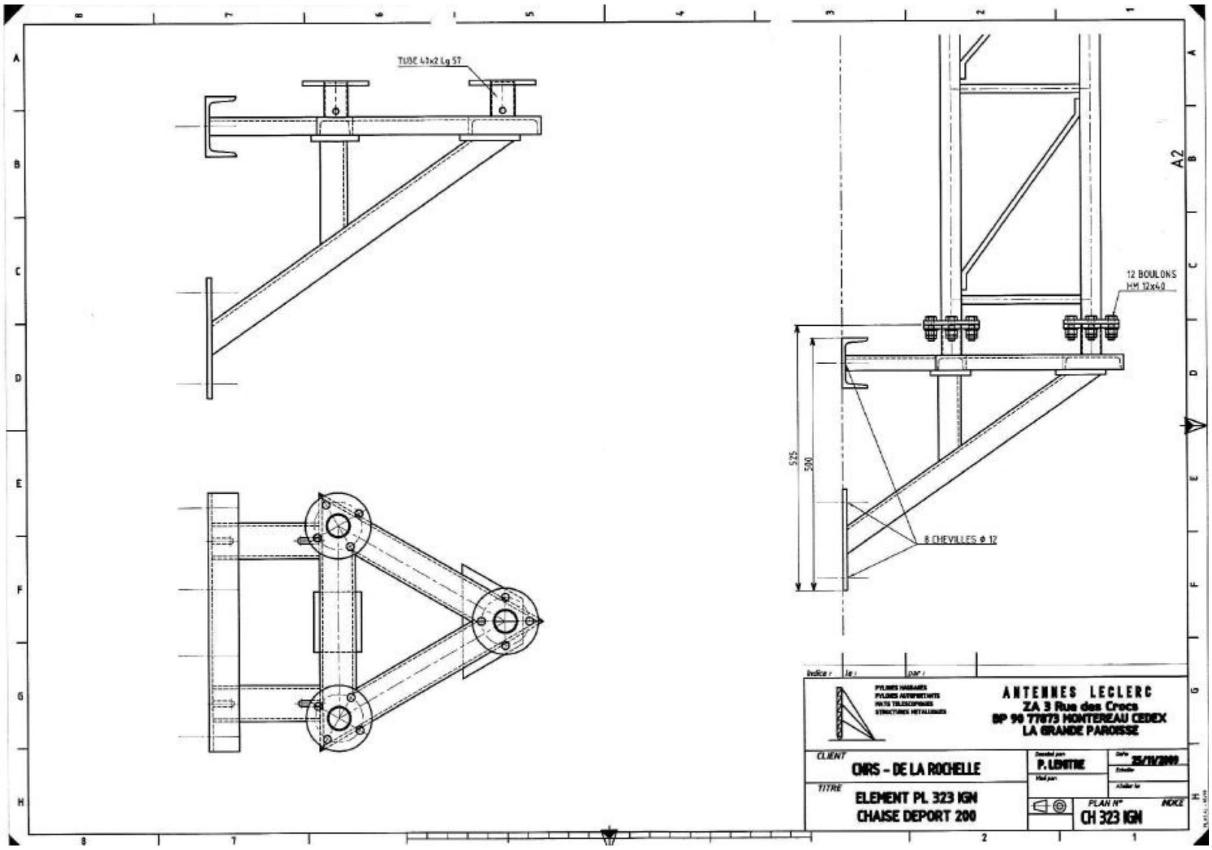
Effort tranchant : 29 daN

Moment fléchissant : 38 m.daN

MASSE DE L'ENSEMBLE : 26 kg

5.8 APPENDIX 8: SPECIFIC MOUNT

On existing construction as building, a specific mount can be use on the vertical part of bearing wall buildings or near support structures.

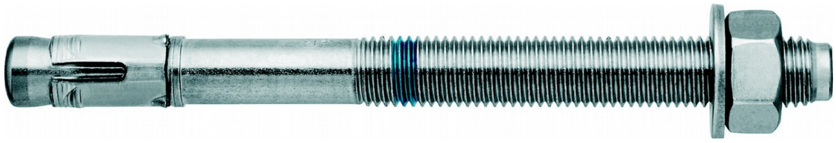


Vertical specific mount

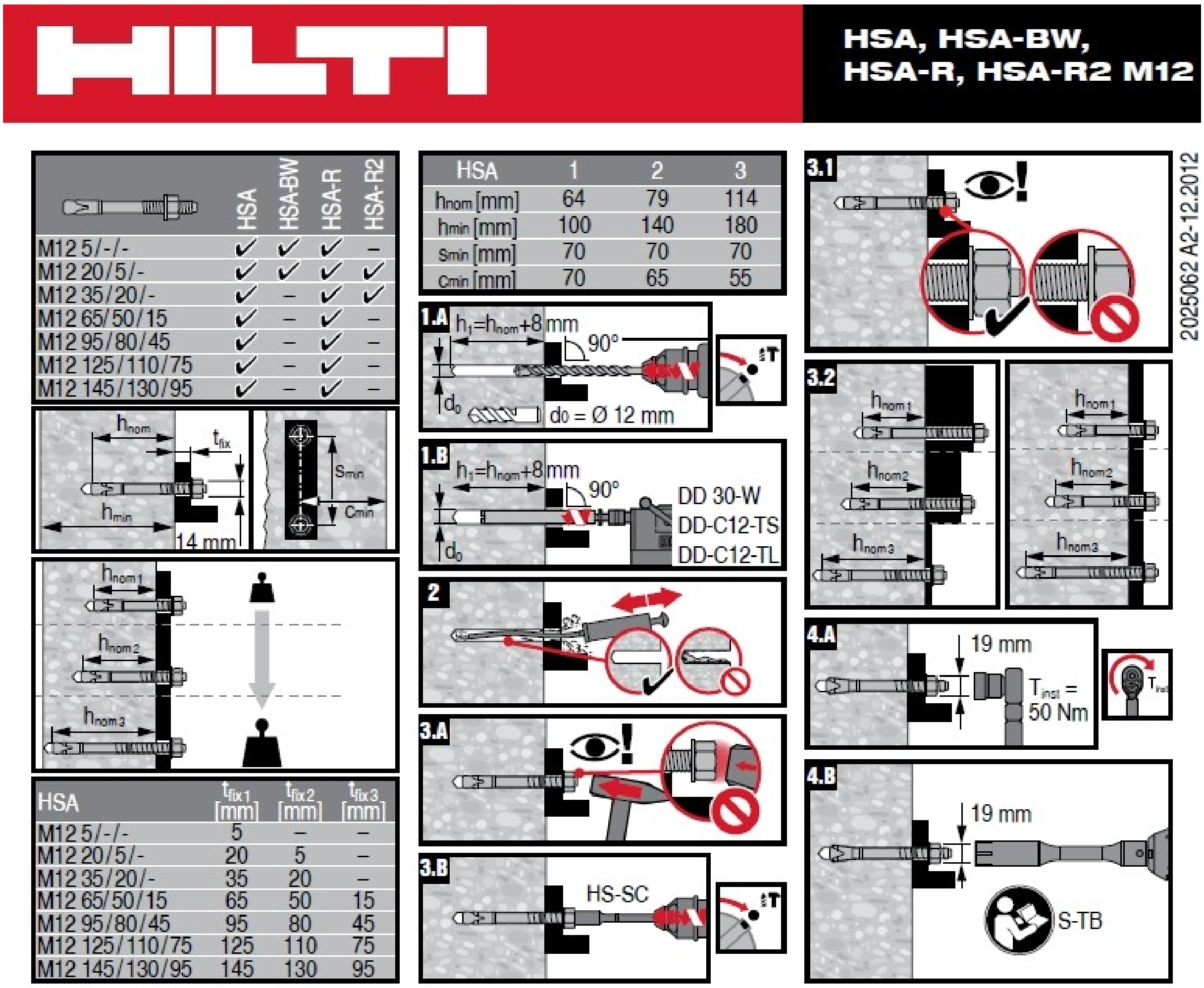
Example of establishment

5.9 APPENDIX 9: FASTENING

Example of fastening: expansion anchors



HILTI HSA-R M12



	HSA	HSA-BW	HSA-R	HSA-R2
M12 5/-/-	✓	✓	✓	–
M12 20/5/-	✓	✓	✓	✓
M12 35/20/-	✓	–	✓	✓
M12 65/50/15	✓	–	✓	–
M12 95/80/45	✓	–	✓	–
M12 125/110/75	✓	–	✓	–
M12 145/130/95	✓	–	✓	–

HSA	1	2	3
hnom [mm]	64	79	114
hmin [mm]	100	140	180
Smin [mm]	70	70	70
Cmin [mm]	70	65	55

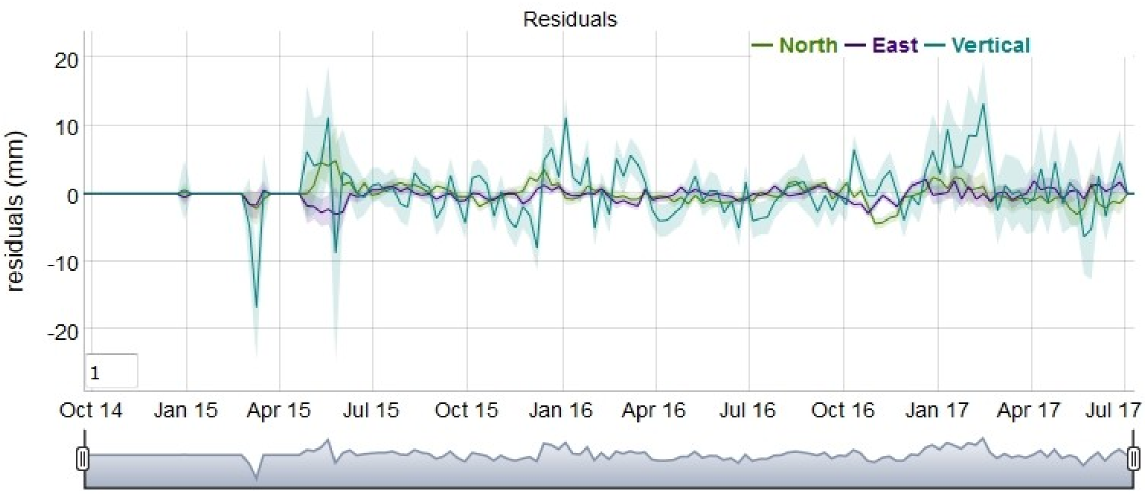
HSA	tfix1 [mm]	tfix2 [mm]	tfix3 [mm]
M12 5/-/-	5	–	–
M12 20/5/-	20	5	–
M12 35/20/-	35	20	–
M12 65/50/15	65	50	15
M12 95/80/45	95	80	45
M12 125/110/75	125	110	75
M12 145/130/95	145	130	95

Instructions for use HSA M12

5.10 APPENDIX 10: EXEMPLE OF MONUMENTATION

METG IGS station (Finland)

OWNG IGS station (New Zealand)



Example of the stability of the METG IGS station (see igs.org)