European Technical Assessment

Self-Drilling Soil and Rock Nail DSI® Hollow Bar System R32-210 to R51-800

ETA-21/0869 of 02.08.2022

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European Technical Assessment

ETA-21/0869 of 02.08.2022

General part

Technical Assessment Body issuing the European Technical Assessment	Österreichisches Institut für Bautechnik (OIB) Austrian Institute of Construction Engineering
Trade name of the construction product	Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800
Product family to which the construction product belongs	Kit for rock and soil nails – Kit with hollow bars for self-drilling nails – Hollow bars of seamless or welded steel tubes
Manufacturer	DSI Underground Austria GmbH Alfred-Wagner-Strasse 1 4061 Pasching Austria
Manufacturing plant	DSI Underground Austria GmbH Alfred-Wagner-Strasse 1 4061 Pasching Austria
This European Technical Assessment contains	33 pages including Annexes 1 to 14, which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with Regulation (EU) № 305/2011, on the basis of	European Assessment Document (EAD) 160088-00-0102 – Kit for rock and soil nails – Kit with hollow bars for self-drilling nails – hollow bars of seamless or welded steel tubes.
This European Technical Assessment replaces	European Technical Assessment ETA-21/0869 of 20.10.2021

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Remarks

Translations of the European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

Specific parts

1 Technical description of the product

1.1 General

The European Technical Assessment[1] – ETA – applies to a kit, the

Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800,

comprising the following components.

- Load-bearing element – Hollow bar in steel
- Drill bit
- Couplings to connect the hollow bars
- Anchorage components for connection to the structure or facing
- Corrosion protection system
- Ancillary components

The assembly of the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800 is shown in Annex 1.

Rock and soil nailing is used in geotechnical applications to construct a supporting structure with nails as tensile elements. The soil and rock nail is inserted into the ground with a sacrificial drill bit by rotary percussive drilling, observing pairs of values for impact energy and torque. The drill bit is selected to be appropriate for the geotechnical conditions on site. Couplings are used to join the hollow bars to the required length of the soil and rock nail, which are locked by the drilling device.

After drilling down to the required depth, the annular void between hollow bar and borehole wall is filled with cement mortar through hollow bar and drill bit. The borehole filling forms a body of cement mortar that transfers the load to the borehole wall – injection nailing.

1.2 Soil and rock nail system

1.2.1 Designation and range of soil and rock nails

The Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, comprises the following nails.

- R32-210, R32-250, R32-280, R32-320, R32-360, R32-400
- R38-420, R38-500, R38-550
- R51-550, R51-660, R51-800

NOTE R denotes rolled rope thread, the numbers 32 to 51 refer to the nominal diameter of the hollow bar in mm and the numbers 210 to 800 to the nominal maximum force of the hollow bar in kN.

[1] ETA-21/0869 was firstly issued in 2021 as European Technical Assessment ETA-21/0869 of 20.10.2021, and amended in 2022 to European Technical Assessment ETA-21/0869 of 02.08.2022.

1.2.2 Anchorage

The nail head comprises a square domed plate or a square flat plate of structural steel with a countersunk bore hole and a hexagonal nut made of steel for quenching and tempering that features a convex shape on one face. For every nominal diameter of the hollow bars, one single hexagonal nut is provided. Preferably the domed plate should be used for small hollow bars and with a direct bearing on shotcrete, concrete or rock.

The nut is shown in Annex 4 and the anchor plates in Annex 5. The plates used for the nails are

- R32-210 to R51-800 domed plates
- R32-210 to R51-800 flat plates

The anchor plate is installed perpendicular to the axis of the hollow bar. Small angular deviations are compensated by the convex shaped face of the nut. The nail is anchored in facing or structure by tightening the nut hand tight.

The nail forces are transferred from hollow bar via nut and plate into structure or facing.

1.2.3 Couplers assembly

To obtain the required length, the nail is extended in coupler assemblies. The coupler assembly comprises a coupling with internal thread and centre stop.

Both hollow bars are screwed into the coupling and tightened with the drilling device to the torques specified in Annex 4. The coupling is shown in Annex 4.

1.2.4 Corrosion protection

Soil and rock nails are suitable for two means of corrosion protection.

- Corrosion protection for temporary soil and rock nails

  Corrosion protection of temporary soil and rock nail is provided by a defined body of cement mortar.

- Corrosion protection for permanent soil and rock nails

  The following techniques are applied to ensure the intended working life of the permanent soil and rock nail.

  - Sacrificial corrosion allowance dependent on the ground conditions, disregarding the system-inherent encapsulation by a body of cement mortar
  - Sacrificial corrosion allowance for bars with hot-dip galvanised coatings, dependent on the ground conditions, disregarding the system-inherent encapsulation by a body of cement mortar

If required, a plastic sleeve is installed prior to setting of the cement mortar to protect the joint between soil and rock nail and structure.

1.3 Components

1.3.1 General

The components of the soil and rock nail are in conformity with the specifications given in Annex 2, Annex 3, Annex 4, Annex 5, and the technical file[2]. Therein the component dimensions, materials, and material identification data with tolerances are given.

The cement mortar is provided at the construction site and is not subject of the ETA.

According to the declaration of the ETA holder, the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, does not contain any dangerous substance.

[2] The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

1.3.2 Load-bearing element – Hollow steel bar

The load bearing member is a longitudinally HF-welded tube in steel for quenching and tempering, made of a low alloyed steel strip with trimmed weld flashes. Calibration to the desired dimension is effected by a warm stretch reduction. The hollow bar meets the requirements of EN 14490[3] on metallic reinforcement.

The hollow bar provides a continuous cold rolled left-handed rope thread, thread R, along its entire length. The rolled thread corresponds to a rope thread in accordance with ISO 1720 or ISO 10208. The average thread height of 1.6 mm and the pitch of 12.7 mm are the same for all hollow bars. The thread profile is shown in Annex 3.

The most important dimensions and characteristic strength values of the hollow bar are listed in Annex 2. Taking corrosion rates into consideration, a loss in cross-sectional area is assumed as specified in Annex 7, resulting in a reduced load-bearing capacity.

Standard lengths of hollow bars are 3 or 4 m. Other lengths may be agreed at the time of enquiry and order.

The hollow bar is neither to be welded nor bent.

1.3.3 Drill bit

The appropriate drill bit is selected subject to the actual diameter of the soil and rock nail, planned nail length, intended cover of cement mortar and geological expected conditions. If required, a specialist possessing the required expert knowledge and experience is consulted.

The Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800 uses a sacrificial drill bit. The drill bit, screwed onto the hollow bar, is used to drill the borehole, form the body of cement mortar and finally remains in the ground, see Annex 1. During installation the hollow bar serves as a drill rod. The drill bit is of no function for the installed soil and rock nail.

1.3.4 Coupling

The coupling is employed to join two hollow bars. The couplings are manufactured from seamless tubes of low alloyed steel for quenching and tempering. The internal thread is machined with a centre stop. For every nominal diameter of the hollow bars two couplings in two different materials are provided.

The coupling is shown in Annex 4.

1.3.5 Anchor plate

Anchor plate is either a square domed plate or a square flat plate with a chamfered bore, either made of structural steel. The domed plate is only used for small hollow bars and if it bears directly onto shotcrete, concrete, or rock. Plates used for the nails are.

- R32-210 to R51-800 domed plates
- R32-210 to R51-800 flat plates

The anchor plates are shown in Annex 5.

1.3.6 Nut

The nut is a hexagonal nut made of steel for quenching and tempering and features a convex shape on one face. For every nominal diameter of the hollow bars two hexagonal nuts in two different materials are provided.

The nut is shown in Annex 4.

[3] Standards and other documents referred to in the European Technical Assessment are listed in Annex 14.

1.3.7 Ancillary components

Ancillary components are spacers and plastic sleeves at the joint soil and rock nail to structure or facing. To result in a defined cover of cement mortar, spacers provide the necessary distance between hollow bar and borehole wall.

The plastic sleeve is shown in Annex 6 and the spacer in Annex 4.

2 Specification of the intended uses in accordance with the applicable European Assessment Document (hereinafter EAD)

2.1 Intended uses

Soil and rock nails are intended to stabilise soil and rock by the installation of passive tensile elements. The soil and rock nails are inserted by drilling and forming a body of cement mortar. The structure is designed as to achieve a redundant structure by nailing. Structures with only one single soil and rock nail are not executed.

The working life of soil and rock nail is defined for the following intended uses, see Table 1.

Table 1 Intended uses

Line №	Soil and rock nail		Working life
1	Temporary soil and rock nail		Up to 2 years
2	Permanent soil and rock nail	Bare soil and rock nail	Up to 50 years
3	Permanent soil and rock nail	Hot-dip galvanised soil and rock nail	Up to 50 years

Permanent soil and rock nails attain a working life of up to 50 years, dependent on the ground conditions, by sacrificial corrosion for the time-dependent corrosion behaviour.

2.2 Assumptions

2.2.1 General

Concerning product packaging, transport, storage, maintenance, replacement, and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on transport, storage, maintenance, replacement, and repair of the product as he considers necessary.

2.2.2 Design

The design of the structure with soil and rock nails is carried out in accordance with the Eurocodes and EN 14490, observing the following items.

- The soil and rock nail is subjected to tensile loads.
- The soil and rock nail system includes temporary and permanent nails.
- A redundant construction ensures that the load-bearing capacity of the structure with soil and rock nails is not impaired, even if individual elements prematurely fail. Applications with only one single nail are not executed.
- The design value for ultimate limit state of the soil and rock nail is assumed according to EN 1992-1-1 with a partial safety factor of 1.15[4] against attainment of the yield force $F_{p0.2,\,nom}$. The values listed in Annex 2 are taken as a basis.

[4] Recommended partial safety factor, to be used in the absence of standards and regulations in force at the place of use.

- The stress range at coupling and anchorage of the soil and rock nail, verified in fatigue testing at an upper load of $0.65 \cdot F_{p0.2,\,nom}$ and $2 \cdot 10^6$ load cycles, is 80 N/mm² for all sizes.
- The minimum centre and edge distances of the soil and rock nails are listed in Annex 8 for a cube compressive strength of concrete of ≥ 38 N/mm², without bursting reinforcement.
- At a force of $0.65 \cdot F_{p0.2,\,nom}$ and with a minimum torque of the couplings as referred to in Annex 4, average slip values and deformations are the following
  - Slip at the locked coupling ..... 0.9 mm
  - Slip at the anchorage with manually tightened nut ..... 0.3 mm
  - Plastic deformation at the contact zone nut – flat plate..... 1.4–1.8 mm
  - Levelling of the domed plate ..... 5–15 mm
- For cement mortar with a cylinder compressive strength of ≥ 55 N/mm², a characteristic bond stress of 5.1 N/mm² is assumed.
- If a corrosion rate (sacrificial corrosion) is taken into consideration, the loss in cross-sectional area is taken into account in the verification of the load-bearing capacity. The respective values are listed in Annex 7. Additional data on permanent nails are specified in Clause 2.2.4.2.
- The hollow bar is not intended to be welded or bent.
- The nail forces are transferred to the facing through the nail head. The facing is designed according to EN 1992-1-1. If required, punching resistance is verified.
- Annex 6 shows the assembly of the soil and rock nail head embedded in concrete with corrosion protection.

2.2.3 Installation

2.2.3.1 General

It is assumed that the product will be installed according to the manufacturer's instructions or – in absence of such instructions – according to the usual practice of the building professionals.

The Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800 is installed in accordance with the requirements of EN 14490, by a specialist company, in accordance with defined procedures, and observing the following items.

- The installation instructions specify the measures required to prevent damage to the hollow bars and couplings during installation.
- The hollow bar is not intended to be welded or bent.
- The nail is installed using the screwed-on drill bit. The drill bit is adapted to the geotechnical conditions at the construction site.
- The nail length is attained by connecting the hollow bars with couplings. Thereby, the hollow bars are locked with the drilling equipment to at least the specified torque according to Annex 4.
- During drilling, torque or pairs of values for impact energy and torque respectively are limited as specified in Annex 10.
- Filling of the annular or flushing cavity with cement mortar takes place via an injection adapter. By means of a rotary injection adapter (flushing head), both, flushing with cement mortar simultaneously with drilling and subsequent filling with cement mortar can be performed.
- All installed nails have a system-inherent body of cement mortar between the nail and the borehole wall. The cement mortar conforms to EN 14490. The cement is selected depending on the aggressiveness of the ground in accordance with EN 206. The water-cement ratio is

appropriate for the actual conditions on the construction site. Alternatively, grout according to EN 445, EN 446, and EN 447 may be used.

- If required, a plastic sleeve is pulled over the nail in the area of the gap between facing and soil or rock prior to setting of the cement mortar, see Annex 6.
- After hardening of the cement mortar, the anchorage is installed. The nut is tightened manually.
- With reference to EN 14490 tests on installed soil nails to verify the pull out resistance and the creep behaviour should be performed. The number and frequency of the tests are defined taking into account the consequences of failure in the structure. Static load test on soil and rock nails should be carried out in accordance with EN 14490, Annex C. The maximum test force should not exceed 80 % of the nominal maximum force, $F_{m,\,nom}$, and 95 % of the nominal yield force, $F_{p0.2,\,nom}$, whichever is smaller. Annex C of EN 14490 provides guidance on the test procedures, including recommendations for acceptance criteria.

2.2.4 Corrosion protection

2.2.4.1 Temporary soil and rock nail

Temporary soil and rock nails are protected against corrosion by means of a 20 mm thick cover of cement mortar on the load-bearing element. The minimum cover is 15 mm. The required thickness of the cover of cement mortar is ensured with spacers, see Annex 4, at a distance of ≤ 3.0 m.

2.2.4.2 Permanent soil and rock nails

2.2.4.2.1 General

By reference to EN 14490, Annex B.3.4, classes of ground aggressiveness and corrosion rates for achieving the intended working life are defined. Values are also listed in Table 4-1 of EN 1993-5.

The Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800 defines corrosion rates (sacrificial corrosion) for a working life of maximum 50 years, depending on the ground conditions and disregarding the system-inherent cover of cement mortar.

- Definition of corrosion rates (sacrificial corrosion) depending on the ground conditions for bare steel, whereby the system-inherent encapsulation with cement mortar is left unconsidered.
- Definition of corrosion rates (sacrificial corrosion) depending on the ground conditions for hot-dip galvanised steel, whereby the system-inherent encapsulation with cement mortar is left unconsidered. The applied mean zinc layer thickness typically is ≥ 85 µm.

  NOTE The soil nail standard EN 14490 also contains a classification of the corrosiveness of the ground and provides data for the corrosion behaviour according to the Soil Nailing Recommendation Clouterre (1991). Compared with the values of Table 3 and Annex 7 and Annex 9, the corrosion depths according to EN 14490 is higher and can by agreement be applied as well.

Further requirements regarding corrosion protection are derived from a critical evaluation of the structure and from the environmental conditions. In particular, a redundant construction ensures that even with premature failure of individual nails, the load bearing capacity of the nail structure is still maintained. Constructions with only one single nail are to be executed.

To avoid the formation of macro elements in moist soils, a conductive connection of the nail and the reinforcement of the adjacent structure is to be avoided. If required, additional measures, e.g., the arrangement of separating layers are provided for, see Annex 6.

The mean zinc layer thickness is typically ≥ 85 µm.

2.2.4.2.2 Corrosion load

EN 12501-1 and EN 12501-2 are to be taken as a basis to evaluate the corrosion load of metallic materials in the ground. The corrosion load is classified as

- Low
- Medium
- High

The most important physical and chemical ground parameters are defined in EN 12501-2. Annex B of the standard contains detailed information on the collection of data for ground classification.

The various corrosion loads are assessed, based on an informative listing of the most important ground parameters, see Table 2. Based on these findings, the relevant corrosion rate of the soil and rock nails due to corrosion is defined. They are listed in Table 3.

Table 2 Criteria for assessing corrosion load in ground

Ground parameter	**Corrosion load in ground**		
	Low	**Medium**	**High**
Ventilation	Very good to moderate	Moderate to poor	Poor to very poor
Ground composition	Predominantly sand, gravel, crushed rock (coarse to medium grained)	High contents of silt, fine sand (medium to fine grained)	Possibly contents of organic substances, high contents of clay (fine grained), industrial waste, de-icing salt
Water content	Low (drainable)	Generally medium (moist)	Generally high, changing water levels
Neutral salt contents	Low	Possibly increased	Possibly high
pH values	5 to 8	5 to 8	5 to 8
Specific ground resistance in Ωm	> 70	10 to 70	< 10

- With pH values of < 5 for bare and galvanised steel and
- with pH values of > 8 for galvanised steel

the corrosion load is assigned to the next higher corrosion load, i.e.,

Low ⇨ Medium
Medium ⇨ High
High ⇨ Reduced working life

2.2.4.2.3 Surface coating by hot-dip galvanising

The specifications of EN 14490, clause 6.2.2.2.6, and Annex B.3.4.6, are the basis for surface coating of the nail, hollow bar and accessories, by hot-dip galvanising.

Corrosion of the hot-dip galvanised nail only commences after degradation of the zinc layer and leads to a delay in corrosion of the steel and thus to an increase working life.

The nails are hot-dip galvanised according to the requirements of EN ISO 1461. The mean zinc layer thickness is typically ≥ 85 µm.

2.2.4.2.4 Corrosion rate (sacrificial corrosion)

Annex 9 and Table 3 include guide values for sacrificial corrosion depths of bare and hot-dip galvanised nails in grounds, derived from the results of long-term exposures. The sacrificial corrosion depths for a low, medium and high corrosion load and a working life of 2, 7, 30 and 50 years is specified. The values are rounded by approximately 0.1 mm.

Table 3 Guide values for sacrificial corrosion depth, see also Annex 9

Working life in years	Nail	Corrosion load		
		Low	Medium	High
		Sacrificial corrosion depth in mm		
2	A B	0 0	0 0	0.2 0.1
7	A B	0.2 0	0.2 0.1	0.5 0.4
30	A B	0.3 0.1	0.6 0.4	— —
50	A B	0.5 0.3	1.0 0.7	— —

Key

Nail A ..... Bare steel
Nail B ..... Hot-dip galvanised steel, mean zinc coat thickness ≥ 85 µm

Annex 7 includes information on the loss in cross-sectional area of the nail due to corrosion. Corrosion at the coupling is considered. A separate verification is not required.

2.2.4.2.5 Corrosion protection of the nail head

The corrosion protection of the nail head is achieved by a cover of at least 50 mm structural concrete or shotcrete, grade ≥ C20/25. Alternatively, a galvanised metal cap or plastic cap filled with a corrosion protective material or cement mortar can be installed. Annex 6 shows the corrosion protection of the nail head.

2.2.4.2.6 Installation

For the installation of permanent nails the following measures are to be observed.

- The corrosion load for metallic materials in ground can be identified and classified according to the specifications in Clause 2.2.4.2.2.

- The corrosion rate (sacrificial corrosion) is determined with the identified soil parameters for the intended working life of the nail in accordance with Clause 2.2.4.2.4. Depending on the nail, the potential loss in cross-sectional area is taken into account. Annex 7 includes data on the loss of cross-sectional area of the nail due to corrosion.
- At "high" corrosion load according to Table 2, an electro conductive contact between the reinforcement of the facing and the nail is to be avoided. At "medium" corrosion load according to Table 2, an electro conductive contact between the reinforcement of the facing and the nail should be avoided.
- In case of elements of reinforced concrete, a plastic sleeve is pulled over the nail in the area of the gap between the reinforced concrete element and the soil or rock. The remaining annular void is filled with cement mortar. The plastic sleeve is placed into the soil or rock to a depth of at least 20 cm.
- The nail head is covered with at least 50 mm of concrete or shotcrete, or with a cap filled with corrosion protection filling material or cement mortar.

  In Annex 6, the corrosion protection of the nail head is shown.

2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800 of up to 2 years for the temporary soil and rock nail and up to 50 years for the permanent soil and rock nail, provided that the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800 is subject to appropriate installation, use, and maintenance, see Clause 2.2.

In normal use conditions the real working life may be considerably longer without major degradation affecting the basic requirements for construction works[5].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee, neither given by the product manufacturer or his representative nor by EOTA nor by the Technical Assessment Body but are regarded only as a means for expressing the expected economically reasonable working life of the product.

3 Performance of the product and references to the methods used for its assessment

3.1 Essential characteristics

The performances of the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, for the essential characteristics are given in Table 4. In Annex 13, the combinations of essential characteristics and corresponding intended uses are listed.

Table 4 Essential characteristics and performances of the product

№	Essential characteristic	Product performance
Basic requirement for construction works 1: Mechanical resistance and stability		
1	Resistance to static load of anchorages and coupler assemblies	See Clause 2.2.2, Clause 3.2.1.1, and Annex 2.

[5] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works are subject, as well as on the particular conditions of design, execution, use, and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the assumed working life.

№	Essential characteristic	Product performance
2	Resistance to fatigue of anchorages and coupler assemblies	See Clause 3.2.1.2 and Annex 2.
3	Load transfer to the structure	See Clause 3.2.1.3 and Annex 2.
4	Corrosion protection for temporary rock and soil nails	See Clause 3.2.1.4, Clause 3.2.1.10, and Clause 3.2.1.12.
5	Corrosion protection, sacrificial corrosion allowance for permanent rock and soil nails	See Clause 3.2.1.5, Clause 3.2.1.10, Clause 3.2.1.12.
6	Corrosion protection, sacrificial corrosion allowance with surface coating by hot-dip galvanisation for permanent rock and soil nails	See Clause 3.2.1.6, Clause 3.2.1.10, Clause 3.2.1.12, and Clause 3.2.1.13.
7	Impact energy and torque	See Annex 10.
8	Shape	See Annex 3.
9	Dimensions	See Annex 2.
10	Surface geometry	See Annex 3.
11	Mass per metre	See Annex 2.
12	Cross-sectional area	See Annex 2.
13	Strength characteristics	See Annex 2.
14	Elongation at maximum force	See Annex 2.
15	Modulus of elasticity	See Annex 2.
16	Weld at flattening	See Clause 3.2.1.7.
17	Weld at drift-expansion	See Clause 3.2.1.8.
18	Resistance to fatigue	See Annex 2.
19	Bond strength	See Annex 2.
20	Hot-dip galvanisation	See Clause 3.2.1.9.
Basic requirement for construction works 2: Safety in case of fire		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 3: Hygiene, health, and the environment		
—	No characteristic assessed.	—
Basic requirement for construction works 4: Safety and accessibility in use		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 5: Protection against noise		
—	Not relevant. No characteristic assessed.	—

№	Essential characteristic	Product performance
Basic requirement for construction works 6: Energy economy and heat retention		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 7: Sustainable use of natural resources		
—	No characteristic assessed.	—

3.2 Product performance

3.2.1 Mechanical resistance and stability

3.2.1.1 Resistance to static load of anchorages and coupler assemblies

The load-bearing capacity of the soil and rock nail is not impaired by anchorage and coupler assembly. Reference thereby is the nominal maximum force of the hollow bar according to Annex 2.

3.2.1.2 Resistance to fatigue of anchorages and coupler assemblies

Performance of resistance to fatigue for anchorage and coupler assembly is 80 N/mm² at at an upper load of $0.65 \cdot F_{p0.2,\,nom}$ and $2 \cdot 10^6$ load cycles.

3.2.1.3 Load transfer to the structure

Dimensions of the square plate are given in Annex 5 and centre spacing and edge distance of the anchorage in Annex 8. Compressive strength of concrete is at least 38 N/mm².

NOTE The anchorage does not require additional reinforcement.

3.2.1.4 Corrosion protection for temporary soil and rock nails

Corrosion protection of the temporary soil and rock nail is described in Clause 2.2.4.1

3.2.1.5 Corrosion protection, sacrificial corrosion allowance for permanent soil and rock nails

Corrosion protection of the bare permanent soil and rock nail is described in Clause 2.2.4.2.

3.2.1.6 Corrosion protection, sacrificial corrosion allowance with surface coating by hot-dip galvanisation for permanent soil and rock nails

Corrosion protection of the permanent hot-dip galvanised soil and rock nail is described in Clause 2.2.4.2.

3.2.1.7 Weld at flattening

Weld at flattening of the steel tube prior to thread rolling is no cracking at close flattening.

3.2.1.8 Weld at drift-expansion

Weld at drift-expansion of the steel tube prior to thread rolling is no cracking at relative expansion ≥ 110 % with 60 ° mandrel.

3.2.1.9 Hot-dip galvanising

The hollow bar is hot-dip galvanised according to the requirements of EN ISO 1461. The mean thickness of the hot-dip galvanised coating is at least 85 µm.

NOTE Other coating thicknesses may be applied and are considered in determining corrosion depths.

3.2.1.10 Shape and dimensions

For shape and dimensions of the components see Table 5.

Table 5 Shape and dimensions of components

Component	Shape and dimensions
Anchor nut	See Annex 4.
Plate	See Annex 5.
Coupling	See Annex 4.

3.2.1.11 Hardness

For hardness of the components see Table 6.

Table 6 Hardness of Components

Component	Hardness HV 30	
	Series A	Series B
Anchor nut	≥ 180	≥ 240
Plate	≥ 115	Same plate as Series A
Coupling	≥ 265	≥ 265

3.2.1.12 Material of components

Materials of the components are listed in Table 7.

Table 7 Material of components

Component	Material
Anchor nut	Steel for quenching and tempering
Plate	Structural steel
Coupling	Seamless steel tube

3.2.1.13 Hot-dip galvanising

Components are hot-dip galvanised according to the requirements of EN ISO 1461. The mean thickness of the hot-dip galvanised coating is at least 85 µm.

NOTE In general, thickness of hot-dip galvanising of components is at least the thickness applied on the hollow bar.

3.3 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, for the intended uses, and in relation to the requirements for mechanical resistance and stability, in the sense of the basic requirement for construction works № 1 of Regulation (EU) № 305/2011 has been made in accordance with the European Assessment Document EAD 160088-00-0102, Kit for rock and soil nails – Kit with hollow bars for self-drilling nails – hollow bars of seamless or welded steel tubes.

3.4 Identification

The European Technical Assessment for the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, is issued on the basis of agreed data that identify the assessed product[6]. Changes to materials, to composition, or to characteristics of the product, or to the production process could result in these deposited data being incorrect. Österreichisches Institut für Bautechnik should be notified before the changes are introduced, as an amendment of the European Technical Assessment is possibly necessary.

4 Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

4.1 System of assessment and verification of constancy of performance

According to the Commission Decision 98/456/EC, the system of assessment and verification of constancy of performance to be applied to the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, is System 1+. System 1+ is detailed in Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, Annex, point 1.1, and provides for the following items.

(a) The manufacturer shall carry out

  (i) factory production control;

  (ii) further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan[7].

(b) The notified product certification body shall decide on the issuing, restriction, suspension or withdrawal of the certificate of constancy of performance of the construction product on the basis of the outcome of the following assessments and verifications carried out by that body

  (i) an assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values, or descriptive documentation of the product;

  (ii) initial inspection of the manufacturing plant and of factory production control;

  (iii) continuing surveillance, assessment, and evaluation of factory production control;

  (iv) audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities.

4.2 AVCP for construction products for which a European Technical Assessment has been issued

Notified bodies undertaking tasks under System 1+ shall consider the European Technical Assessment issued for the construction product in question as the assessment of the performance of that product. Notified bodies shall therefore not undertake the tasks referred to in Clause 4.1, point (b) (i).

---

6 The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

7 The prescribed test plan has been deposited with Österreichisches Institut für Bautechnik and is handed over only to the notified product certification body involved in the procedure for the assessment and verification of constancy of performance. The prescribed test plan is also referred to as control plan.

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

5.1 Tasks for the manufacturer

5.1.1 Factory production control

In the manufacturing plant, the manufacturer establishes and continuously maintains a factory production control. All procedures and specifications adopted by the manufacturer are documented in a systematic manner. Purpose of factory production control is to ensure the constancy of performances of the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, with regard to the essential characteristics.

The manufacturer only uses raw materials supplied with the relevant inspection documents as laid down in the control plan. The incoming raw materials are subjected to controls by the manufacturer before acceptance. Check of incoming materials includes control of inspection documents presented by the manufacturer of the raw materials.

Testing within factory production control is in accordance with the prescribed test plan. The results of factory production control are recorded and evaluated. The records are presented to the notified product certification body involved in continuous surveillance and are kept at least for ten years after the product has been placed on the market. On request, the records are presented to Österreichisches Institut für Bautechnik.

If test results are unsatisfactory, the manufacturer immediately implements measures to eliminate the defects. Products or components that are not in conformity with the requirements are removed. After elimination of the defects, the respective test – if verification is required for technical reasons – is repeated immediately.

At least once a year the manufacturer audits the manufacturers of nuts and couplings.

The basic elements of the prescribed test plan are given in Annex 11.

5.1.2 Declaration of performance

The manufacturer is responsible for preparing the declaration of performance. When all the criteria of the assessment and verification of constancy of performance are met, including the certificate of constancy of performance issued by the notified product certification body, the manufacturer draws up the declaration of performance. Essential characteristics to be included in the declaration of performance for the corresponding intended use are given in Clause 3.1, Table 4. In Annex 13 the combinations of essential characteristics and corresponding intended uses are listed.

5.2 Tasks for the notified product certification body

5.2.1 Initial inspection of the manufacturing plant and of factory production control

The notified product certification body verifies the ability of the manufacturer for a continuous and orderly manufacturing of the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, according to the European Technical Assessment. In particular, the following items are appropriately considered.

- Personnel and equipment
- Suitability of the factory production control established by the manufacturer
- Full implementation of the prescribed test plan

5.2.2 Continuing surveillance, assessment, and evaluation of factory production control

The notified product certification body visits the factory at least once a year for routine inspection. Inspection of factory production control of steel bar is twice a year. In particular the following items are appropriately considered.

- Manufacturing process including personnel and equipment
- Factory production control
- Implementation of the prescribed test plan

Each manufacturer of nuts and couplings is audited at least once in five years. It is verified that the system of factory production control and the specified manufacturing process are maintained, taking account of the prescribed test plan.

The results of continuous surveillance are made available on demand by the notified product certification body to Österreichisches Institut für Bautechnik. When the provisions of the European Technical Assessment and the prescribed test plan are no longer fulfilled, the certificate of constancy of performance is withdrawn by the notified product certification body.

5.2.3 Audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities

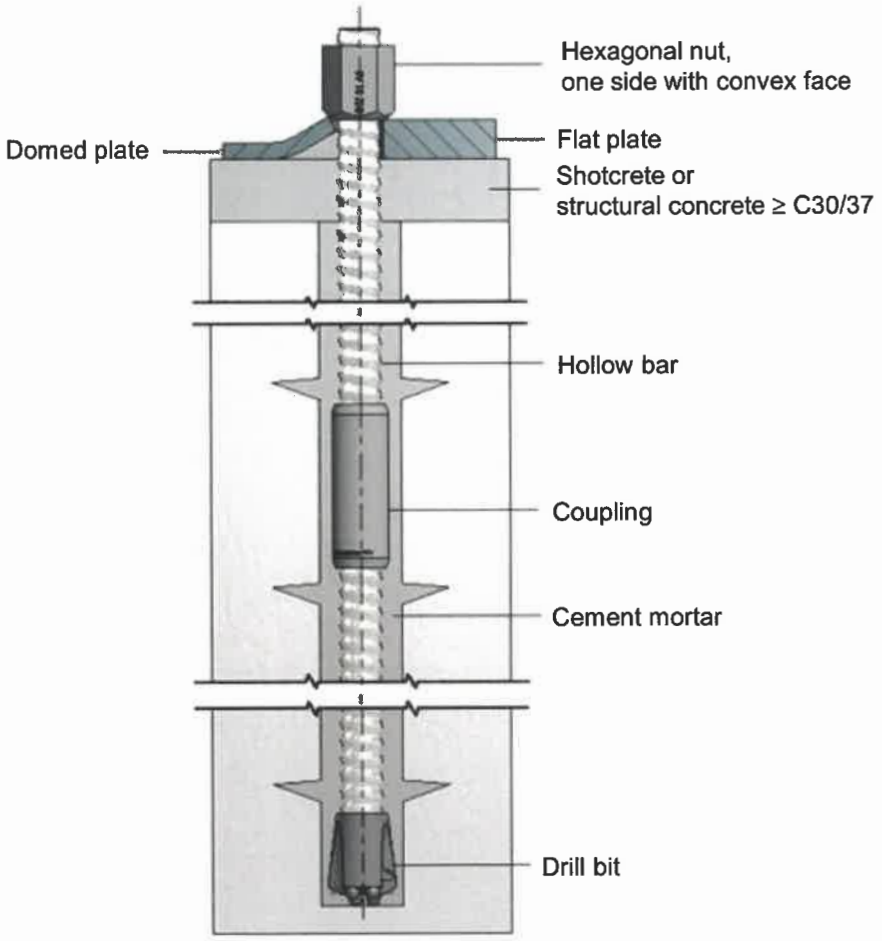
During surveillance inspections, the notified product certification body takes samples of components of the Self-drilling soil and rock nail DSI® Hollow Bar System, R32-210 to R51-800, for independent testing. For the most important components, Annex 12 summarises the minimum procedures performed by the notified product certification body.

Issued in Vienna on 02 August 2022
by Österreichisches Institut für Bautechnik

The original document is signed by:

Rainer Mikulits
Managing Director

Soil and rock nail assembly



Soil and rock nail sizes

Nominal hollow bar diameter and nominal tensile load bearing capacity

Soil and rock nail			R32	R38	R51
Nominal diameter	$D_{e,\,nom}$	mm	32	38	51
Nominal maximum force	$F_{m,\,nom}$	kN	210	420	550
			250	500	660
			280	550	800
			320	—	—
			360	—	—
			400	—	—

Hollow bar – Characteristics

Characteristic			Hollow bar					
			R32-210	R32-250	R32-280	R32-320	R32-360	R32-400
Nominal external diameter	$D_{e,\,nom}$	mm	32					
Actual external diameter	D_e	mm	31.1					
Internal diameter, average [1]	D_i	mm	21.0	20.0	18.5	16.5	15.0	12.5
Nominal cross-sectional area [2]	S_0	mm²	340	370	410	470	510	560
Nominal mass per metre [3]	m	kg/m	2.65	2.90	3.20	3.70	4.00	4.40
Relative rib area	f_R	—	0.13					
Nominal yield force [4]	$F_{p0.2,\,nom}$	kN	160	190	220	250	280	330
Nominal maximum force [4]	$F_{m,\,nom}$	kN	210	250	280	320	360	400
Yield strength [5]	$R_{p0.2}$	N/mm²	470	510	540	530	550	590
Tensile strength [5]	R_m	N/mm²	620	680	680	680	710	710
Ratio $R_m/R_{p0.2}$ [6]	—	—	≥ 1.15					
Elongation at maximum force [6]	A_{gt}	%	≥ 5.0					
Fatigue strength $2 \cdot \sigma_a$ [7]	—	N/mm²	190					
Bond strength [8]	τ_{ak}	N/mm²	5.1					

Characteristic			Hollow bar					
			R38-420	R38-500	R38-550	R51-550	R51-660	R51-800
Nominal external diameter	$D_{e,\,nom}$	mm	38			51		
Actual external diameter	D_e	mm	37.8			49.8		
Internal diameter, average [1]	D_i	mm	21.5	19.0	17.0	34.5	33.0	29.0
Nominal cross-sectional area [2]	S_0	mm²	660	750	800	890	970	1 150
Nominal mass per metre [3]	m	kg/m	5.15	5.85	6.25	6.95	7.65	9.00
Relative rib area	f_R	—	0.13					
Nominal yield force [4]	$F_{p0.2,\,nom}$	kN	350	400	450	450	540	640
Nominal maximum force [4]	$F_{m,\,nom}$	kN	420	500	550	550	660	800
Yield strength [5]	$R_{p0.2}$	N/mm²	530	530	560	510	560	560
Tensile strength [5]	R_m	N/mm²	640	670	690	620	680	700
Ratio $R_m/R_{p0.2}$ [6]	—	—	≥ 1.15					
Elongation at maximum force [6]	A_{gt}	%	≥ 5.0					
Fatigue strength $2 \cdot \sigma_a$ [7]	—	N/mm²	190					
Bond strength [8]	τ_{ak}	N/mm²	5.1					

1) Calculated with nominal dimensions, rounded

2) Calculated from the nominal mass per metre, m, $S_0 = \frac{10^3 \cdot m}{7.85}$

3) Permitted deviation – 4.5 % to + 12 %

4) Characteristic value as 5 %-fractile

5) Calculated with nominal force and nominal cross-sectional area, rounded

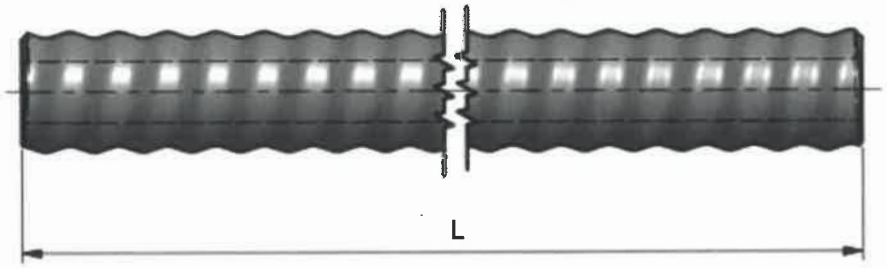
6) Characteristic value as 10 %-fractile

7) Determined with an upper force $F_{up} = 0.7 \cdot F_{p0.2,\,nom}$ and $2 \cdot 10^6$ load cycles

8) Characteristic values, determined in pull out tests with cement mortar of ≥ 55 N/mm² compressive strength

Modulus of elasticity E ≈ 205 000 N/mm²

Geometry

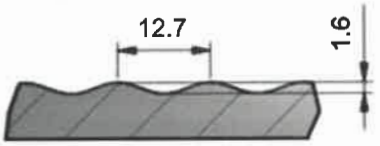


Length in mm
1 000
2 000
3 000
4 000
6 000

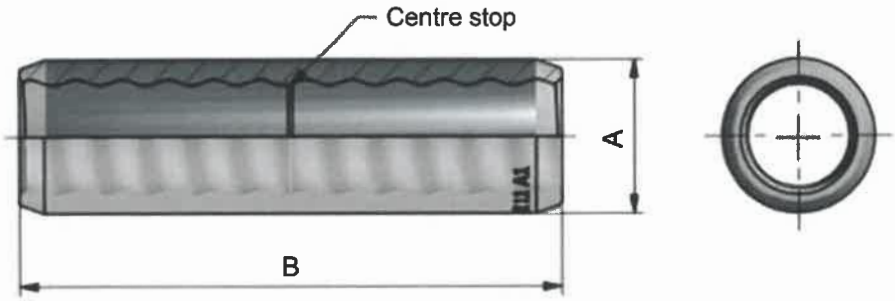
D_e..... External diameter
D_i ..... Internal diameter

Thread profile

Left-hand rope thread R,
following ISO 1720 and ISO 10208



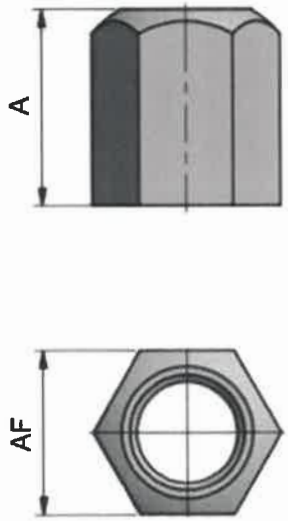
Coupling



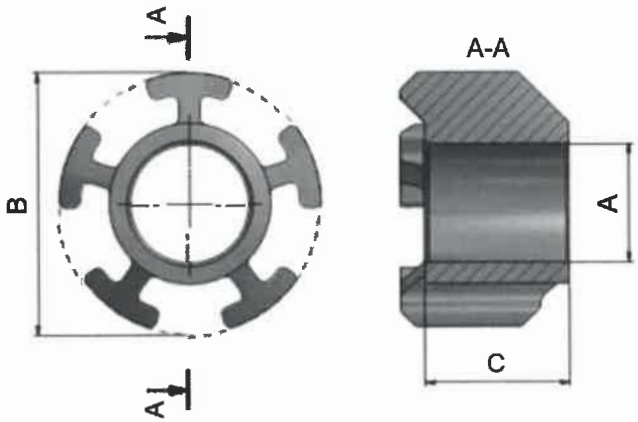
Component			Soil and rock nail					
			Series A			Series B		
			R32	R38	R51	R32	R38	R51
Coupling [1]	A	mm	42.4	51.0	63.5	42.0	51.0	63.0
	B	mm	150	170	200	160	180	200
Hexagonal nut	A	mm	55	70	80	45	60	80
	AF	mm	46	55	75	46	50	75
Spacer	A	mm	33	39	51	Same spacer as Series A		
	B	mm	73	84	95			
	C	mm	40	45	60			

[1] Minimum torque 500 Nm

Hexagonal nut



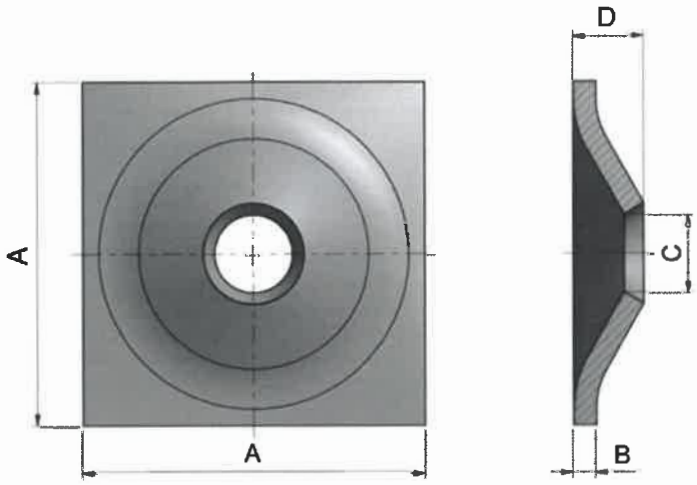
Spacer



DSI UNDERGROUND A SANDVIK COMPANY	DSI Underground Austria GmbH Alfred-Wagner-Straße 1 4061 Pasching/Linz Austria Phone +43-7229-61049-0 Fax ext. 81 www.dsiunderground.at	**DSI® Hollow Bar System** Coupling, hexagonal nut, and spacer – Dimensions

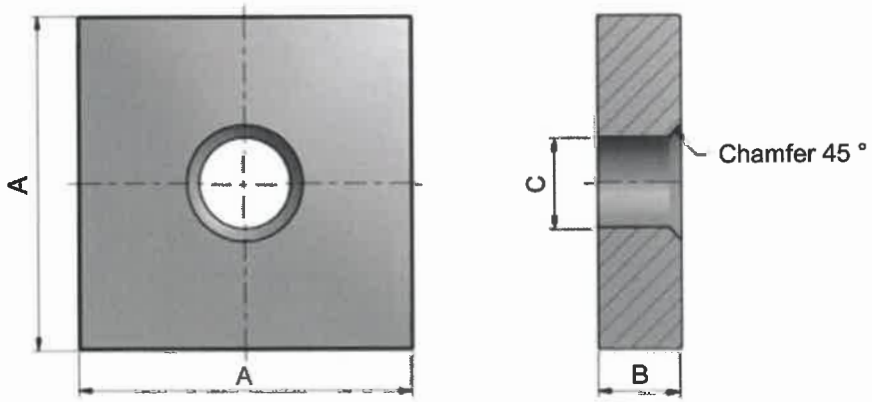
Annex 4
of European Technical Assessment
ETA-21/0869 of 02.08.2022

Domed plate



Domed plate		Soil and rock nail											
		R32-210	R32-250	R32-280	R32-320	R32-360	R32-400	R38-420	R38-500	R38-550	R51-550	R51-660	R51-800
A	mm	150	150	200	200	200	200	200	200	200	200	200	200
B	mm	8	8	10	12	12	12	12	15	15	15	15	20
C	mm	34	34	34	34	34	34	41	41	41	55	55	55
D	mm	31	31	31	31	31	31	31	31	31	31	31	31

Flat plate



Flat plate		Soil and rock nail											
		R32-210	R32-250	R32-280	R32-320	R32-360	R32-400	R38-420	R38-500	R38-550	R51-550	R51-660	R51-800
A	mm	200	200	200	200	200	200	200	200	200	200	200	200
B	mm	20	20	20	20	20	20	30	30	30	35	35	35
C	mm	35	35	35	35	35	35	41	41	41	60	60	60

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DSI® Hollow Bar System
Domed and flat plate
Dimensions

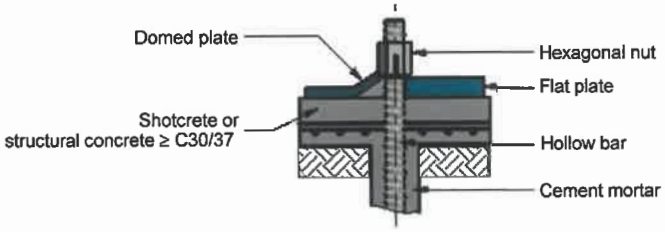
Annex 5
of European Technical Assessment
ETA-21/0869 of 02.08.2022

Corrosion protection of the soil and rock nail head

Temporary nail

Working life ≤ 2 years

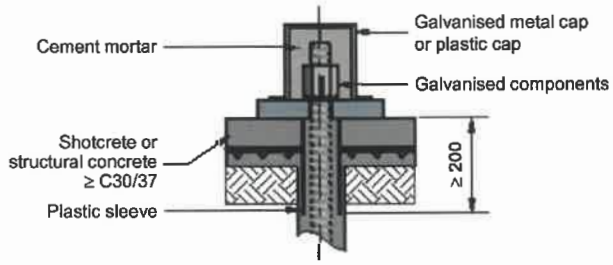
Under high corrosion load, a plastic sleeve is placed in the transition zone nail head to soil or rock, see below.

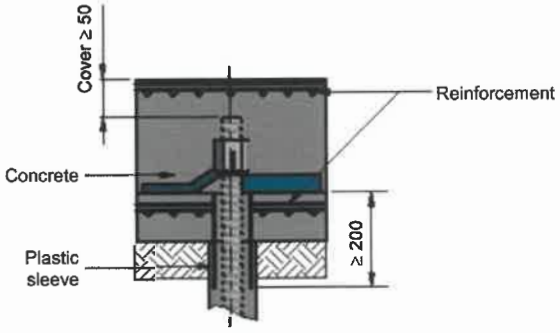


Permanent nail

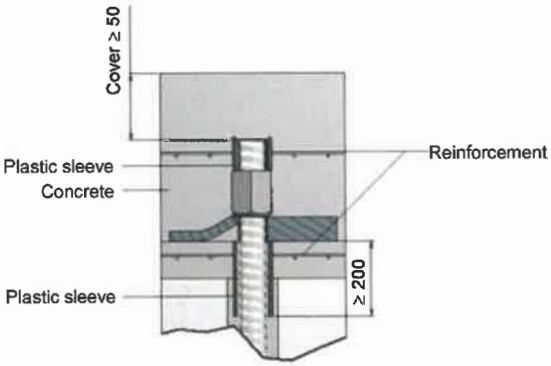
Working life ≤ 50 years

Working life at high corrosion load ≤ 7 years





Example of the isolation of the hollow bar to the reinforcement of the adjacent construction to avoid macro element formation in wet soil.



Plastic sleeve, smooth or corrugated

Hollow bar nominal diameter	Plastic sleeve	
	Inner diameter	Wall thickness
mm	mm	mm
32	≥ 32	≥ 1.0
38	≥ 38	
51	≥ 51	

Dimensions in mm

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DSI® Hollow Bar System
Nail head
Corrosion protection

Annex 6
of European Technical Assessment
ETA-21/0869 of 02.08.2022

Loss in cross-sectional area due to corrosion

Corrosion depth	Hollow bar					
	R32-210	R32-250	R32-280	R32-320	R32-360	R32-400
	Loss in cross-sectional area [1]					
mm	%	%	%	%	%	%
0	0	0	0	0	0	0
0.1	3	3	2	2	2	2
0.2	6	5	5	4	4	4
0.3	9	8	7	6	6	5
0.4	12	11	10	8	8	7
0.5	15	13	12	11	10	9
0.6	17	16	14	13	12	11
0.7	20	19	17	15	13	12
1	29	26	24	21	19	17

Corrosion depth	Hollow bar					
	R38-420	R38-500	R38-550	R51-550	R51-660	R51-800
	Loss in cross-sectional area [1]					
mm	%	%	%	%	%	%
0	0	0	0	0	0	0
0.1	2	2	1	2	2	1
0.2	4	3	3	4	3	3
0.3	5	5	4	5	5	4
0.4	7	6	6	7	7	6
0.5	9	8	7	9	8	7
0.6	11	9	9	11	10	8
0.7	12	11	10	13	11	10
1	18	16	15	18	16	14

[1] Loss of cross-sectional area are based on nominal external diameter and nominal cross-sectional area

Centre and edge distances

Mechanical anchorage without additional reinforcement, i.e., without bursting reinforcement

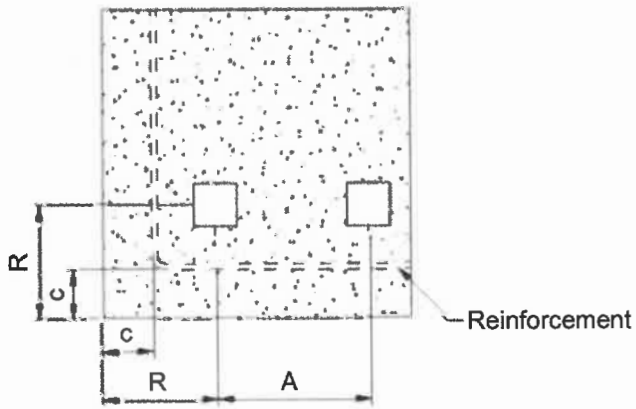
Concrete compressive strength ≥ 38 N/mm²

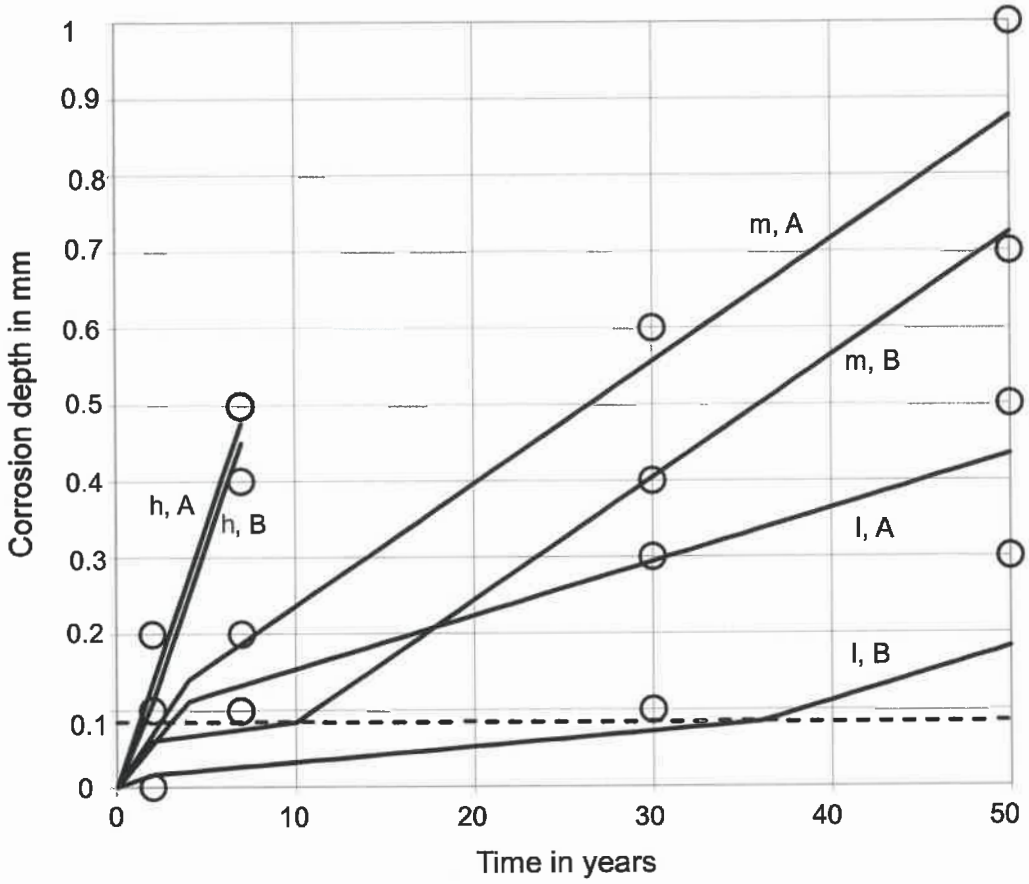
Minimum concrete grade ≥ C30/37

Hollow bar [1)]	Centre distance A	Edge distance R
	mm	mm
R32-210	360	170 + c
R32-250		
R32-280		
R32-320		
R32-360		
R32-400		
R38-420		
R38-500		
R38-550		
R51-550		
R51-660		
R51-800	400	190 + c

c ....Concrete cover of reinforcement

Exposure classes according to EN 206 are considered.





Years	Steel	Corrosion load		
		low	medium	high
		Corrosion depth in mm		
2	A	0	0	0.2
	B	0	0	0.1
7	A	0.2	0.2	0.5
	B	0	0.1	0.4
30	A	0.3	0.6	—
	B	0.1	0.4	—
50	A	0.5	1.0	—
	B	0.3	0.7	—

Key

Soil aggressiveness
l.....low
m.....medium
h.....high

Steel
A..... bare steel
B..... hot-dip galvanised

Figure
- - ..... zinc layer, thickness 85 µm
O ..... tabular values

NOTE
Tabular values are rounded.

Recommended pairs of impact energy and torque for installation

Range	Parameter		Soil and rock nail					
			R32-210	R32-250	R32-280	R32-320	R32-360	R32-400
$\frac{E_{S,max}}{2}$	E_S	Joule	70	80	90	110	120	140
	M_t	Nm	440	480	520	570	600	620
$\frac{M_{t,max}}{2}$	E_S	Joule	110	120	140	160	180	200
	M_t	Nm	320	340	370	410	430	450

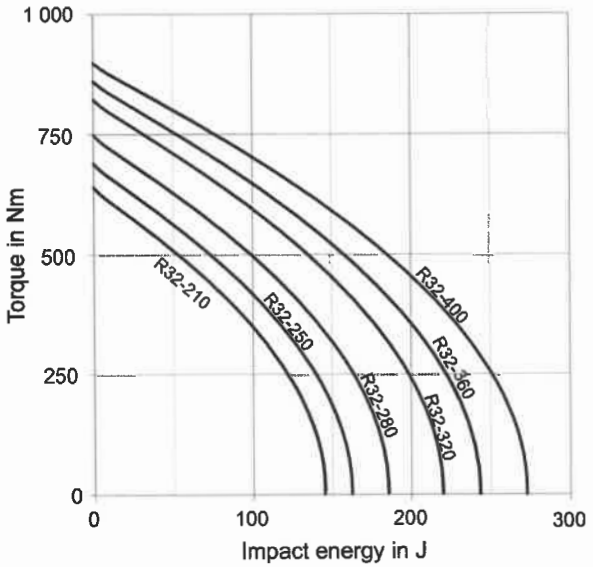
Range	Parameter		Soil and rock nail					
			R38-420	R38-500	R38-550	R51-550	R51-660	R51-800
$\frac{E_{S,max}}{2}$	E_S	Joule	140	160	170	140	150	190
	M_t	Nm	1 000	1 080	1 120	1 860	2 000	2 270
$\frac{M_{t,max}}{2}$	E_S	Joule	200	230	250	190	220	270
	M_t	Nm	730	790	810	1 400	1 500	1 700

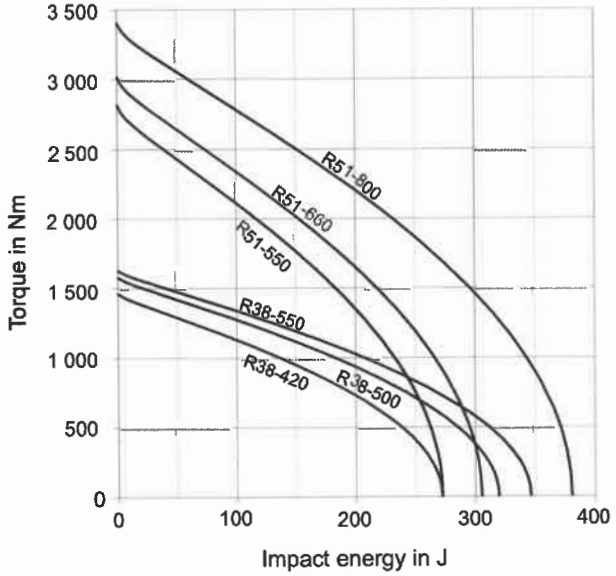
Key E_S .... Impact energy
M_t .... Torque

During installation impact energy and torque are limited to the pairs of value given above.

For applications outside these specifications, the torque-impact energy diagrams below are observed.

Torque-impact energy diagrams





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DSI® Hollow Bar System
Impact energy and torque for installation
Recommended pairs of values

Annex 10
of European Technical Assessment
ETA-21/0869 of 02.08.2022

Subject / type of control		Test of control method	Criteria, if any	Minimum number of samples [1]	Minimum frequency of control
Static load-bearing capacity of anchorage		Testing	[2]	0.2 % [3], [4], ≥ 2 [4]	per year
Static load-bearing capacity of coupler assembly		Testing	[2]	0.2 % [3], [4], ≥ 2 [4]	per year
Resistance to fatigue of anchorage		Testing	[2]	1 [4]	per year
Resistance to fatigue of coupler assembly		Testing	[2]	1 [4]	per year
Hollow bar	Dimensions	Testing	[2]	3 [5]	continuous
	Surface geometry	Testing	[2]	3 [5]	continuous
	Mass per metre	Testing	[2]	3 [5]	continuous
	Cross-sectional area	Testing	[2]	3 [5]	continuous
	Strength properties	Testing	[2]	3 [5]	continuous
	Visual inspection [6]	Checking	[7]	100 %	continuous
Nuts and couplers	Dimensions	Testing	[2]	0.5 % [8], [9], ≥ 3 [4]	per year
	Hardness	Testing	[2]	0.5 % [8], ≥ 3 [4]	per year
	Static load-bearing capacity	Testing [10]	[2]	0.1 % [8], ≥ 2 [4]	per year
	Material	Testing	[2]	100 %	per year
	Visual inspection [6]	Checking	[2]	100 %	per year
Anchor plate	Dimensions	Testing	[2]	0.5 % [8], [9], ≥ 3 [3]	per year
	Material	Testing	[2]	100 %	per year
	Visual inspection [6]	Checking	[7]	100 %	per year
Hot-dip galvanisation	Coating thickness	Testing	[2]	[12]	continuous
	Visual inspection [6]	Checking	[13]	100 %	continuous

1) For two specified numbers of samples, the higher number applies
2) According to the specification of the item
3) Percentage of produced anchorages and of produced couplers per diameter. If all test results have been satisfactory, the minimum frequency may be reduced to 0.1 % after 20 batches of nuts and couplers, at the latest however after 5 years.
4) Per component and diameter. In case of a production of less than 20 anchorages or couplers of a diameter per year, testing is not required. However, the components of all diameters shall be tested within 5 years.
5) Per diameter and rolling batch, at least however as specified in EN 10080, Clause 8.1.
6) Successful visual inspection does not need to be documented.
7) Visual inspection means e.g., main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, corrosion, according to the component's specification.
8) Percentage of produced components per diameter.
9) For small-scale production (≤ 500 pieces), the frequency shall be increased to 5 % of the produced components per diameter and batch.
10) The static load-bearing capacity of nuts and couplers is tested in tensile tests with high-strength steel bolts having the same thread as the hollow bars. The couplers are loaded up to failure, the nuts up to a specified test load. These tests may be replaced by an inspection certificate "3.1" of the material according to EN 10204.
11) Test report type "2.2" according to EN 10204
12) The number of tests for one sample is defined in EN ISO 1461.
13) Visual inspection means e.g., relevant dimensions of zinc coating, gauge testing, correct marking or labelling, surface with regard to zinc flux and zinc ash residues.

Subject / type of control		Test of control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Static load test of anchorage		Testing	1)	1 2)	Each inspection
Static load test of coupler assembly		Testing	1)	1 2)	Each inspection
Hollow bar	Mass per metre	Testing	1)	3)	Each inspection
	Cross-sectional area	Testing	1)	3)	Each inspection
	Surface geometry	Testing	1)	3)	Each inspection
	Strength properties	Testing	1)	3)	Each inspection
	Material	Testing	1)	3)	Each inspection
	Visual inspection	Checking	4)	3)	Each inspection
	Hollow bar, surface coating by hot-dip galvanising	Testing	5)	3 6)	Each inspection
Nuts, couplers, and anchor plates	Dimensions	Testing	1)	3 7)	Each inspection
	Material	Testing	1)	3 7)	Each inspection
	Visual inspection	Checking	4)	3 8)	Each inspection
	Hollow bar, surface coating by hot-dip galvanising	Testing	5)	3 7)	Each inspection

1) According to the specification of the item.

2) 1 diameter, all diameters shall be tested within 5 years.

3) According to EN 10080, Clause 8.3.2.

4) Visual inspection means e.g., main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, corrosion, according to the component's specification.

5) Coating according to the specification of the component, including visual inspection, e.g., relevant dimensions of zinc coating, gauge testing, correct marking or labelling, surface with regard to zinc flux and zinc ash residues.

6) One diameter, all diameters shall be tested within 5 years.

7) Per component. One diameter shall be sampled. All diameters shall be sampled within 5 years.

8) Each kind of component for all diameters.

Essential characteristics for the intended uses

№ [1]	Essential characteristic	Intended use Line № according to Clause 2.1, Table 1		
		1	2	3
	Soil and rock nail			
1	Resistance to static load of anchorages and coupler assemblies	+	+	+
2	Resistance to fatigue of anchorages and coupler assemblies	+	+	+
3	Load transfer to the structure	+	+	+
4	Corrosion protection for temporary rock and soil nails	+	—	—
5	Corrosion protection, sacrificial corrosion allowance for permanent rock and soil nails	—	+	—
6	Corrosion protection, sacrificial corrosion allowance with surface coating by hot-dip galvanisation for permanent rock and soil nails	—	—	+
7	Impact energy and torque	+	+	+
	Hollow bar of welded steel tube			
8	Shape	+	+	+
9	Dimensions	+	+	+
10	Surface geometry	+	+	+
11	Mass per metre	+	+	+
12	Cross-sectional area	+	+	+
13	Strength characteristics	+	+	+
14	Elongation at maximum force	+	+	+
15	Modulus of elasticity	+	+	+
16	Weld at flattening	+	+	+
17	Weld at drift-expansion	+	+	+
18	Resistance to fatigue	+	+	+
19	Bond strength	+	+	+
20	Hot-dip galvanising	—	—	+

[1] № according to Clause 3.1, Table 4.

For combinations of intended uses, the essential characteristics of all intended uses composing the combinations are relevant.

EAD 160088-00-0102	Kit for rock and soil nails – Kit with hollow bars for self-drilling nails – Hollow bars of seamless or welded steel tubes
EN 206+A2, 2021	Concrete – Part 1: Specification performance, production and conformity
EN 445, 2007	Grout for prestressing tendons – Test methods
EN 446, 2007	Grout for prestressing tendons – Grouting procedures
EN 447, 2007	Grout for prestressing tendons – Basic requirements
EN 1992-1-1, 2004 EN 1992-1-1/AC, 2010 EN 1992-1-1/A1, 2014	Eurocode 2 – Design of concrete structures – Part 1-1: General rules and rules for buildings
EN 1993-5, 2007 EN 1993-5/AC, 2009	Eurocode 3 – Design of steel structures – Part 5: Piling
EN 10080, 2005	Steel for the reinforcement of concrete – Weldable reinforcing steel – General
EN 10204, 2004	Metallic products – Types of inspection documents
EN 12501-1, 2003	Protection of metallic materials against corrosion – Corrosion likelihood in soil – Part 1: General
EN 12501-2, 2003	Protection of metallic materials against corrosion – Corrosion likelihood in soil – Part 2: Low alloyed and non alloyed ferrous materials
EN 14490, 2010	Execution of special geotechnical works – Soil nailing
EN ISO 1461, 2009	Hot dip galvanised coatings on fabricated iron and steel articles – Specifications and test methods
ISO 1720, 1974	Rock drilling – Extension drill-steel equipment for percussive long-hole drilling – Rope-threaded equipment 1 1/2 to 2 in (38 to 51 mm)
ISO 10208, 1991	Rock drilling equipment – Left-hand rope threads
98/456/EC	Commission decision 98/456/EC of 3 July 1998 on the procedure for attesting the conformity of construction products pursuant to Article 20 (2) of Council Directive 89/106/EEC as regards posttensioning kits for the prestressing of structures, Official Journal of the European Communities L 201 of 17 July 1998, p. 112
305/2011	Regulation (EU) № 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88 of 4 April 2011, p. 5, amended by Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, OJ L 157 of 27.05.2014, p. 76, Commission Delegated Regulation (EU) № 574/2014 of 21 February 2014, OJ L 159 of 28.05.2014, p. 41, and Regulation (EU) 2019/1020 of the European Parliament and of the Council of 20 June 2019, OJ L 169 of 15.06.2019, p. 1
568/2014	Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014 amending Annex V to Regulation (EU) № 305/2011 of the European Parliament and of the Council as regards the assessment and verification of constancy of performance of construction products, OJ L 157 of 27 May 2014, page 76

All dimensions, weights, quantities, and specifications are those applicable at the time of this publication and may be amended from time to time. Please contact your local representative for final confirmation of any key specifications.