
MECHANICAL
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SPLICES
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The next generation of rebar couplers

AFCAB
DISPOSITIFS DE RABOUTAGE OU D'ANCRAGE D'ARMATURES DU BÉTON
n° M09/012
CONCRETE REINFORCEMENT SPLICING and ANCHORING SYSTEMS

CARES
TECHNICAL APPROVAL
UKAS PRODUCT CERTIFICATION
5039

CARES
UKAS QUALITY MANAGEMENT
1323

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"Concrete and steel have never been so intimately bonded."

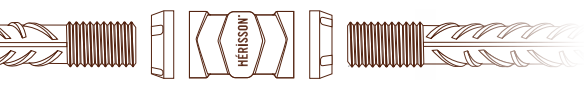
The next generation of rebar couplers provide:

- optimal bonding
- minimum overall dimensions
- ensured continuity
- unrivalled quality of resistance
- simple assembly
- maximum safety

Hérisson® rebar couplers: a range of high performance rebar couplers designed to provide optimal bonding with concrete. With unrivalled qualities of resistance, the rebar couplers ensure reinforced concrete with maximum safety. Concrete and steel have never been so intimately bonded!

Hérisson *or Hedgehog*

The word 'Hedgehog' refers to a small insectivorous mammal that has a coat of sharp, stiff spikes. We use the hedgehog as a symbolic representation of our coupler, which has a 'prickly' characteristic enhancing its bonding properties to the concrete around it.



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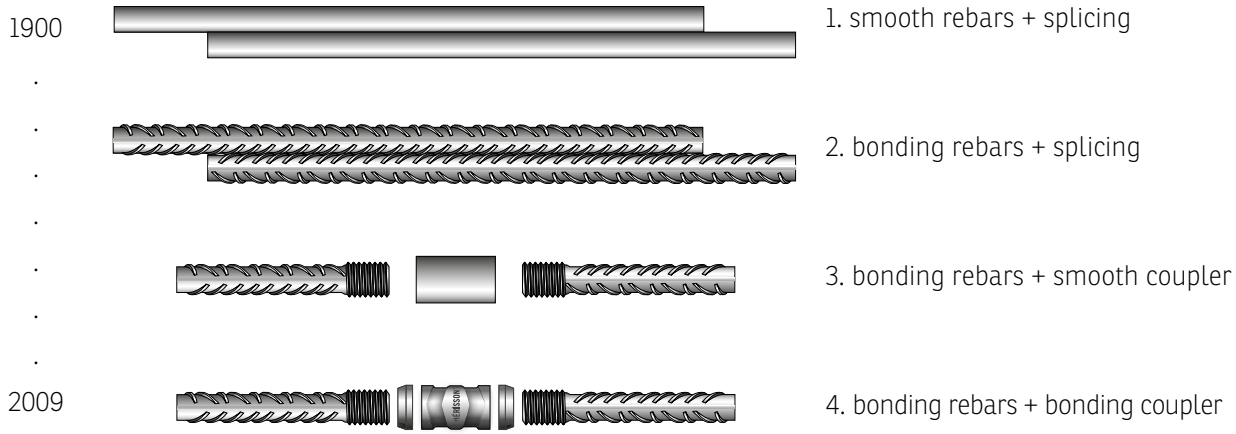
The next generation of rebar couplers

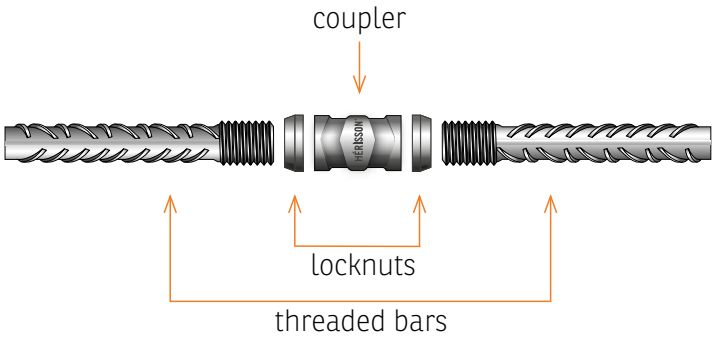
Reinforced concrete is achieved through the combination of concrete with steel rebars which compensate for the poor resistance of concrete to tension. Bonding is an essential aspect to achieve an effective combination...

Major milestones in the development of rebar couplers



Hérisson®
rebar splices

Vocabulary



The combination of these components is the basis for the high quality of Hérisson® rebar splices.

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Ensured continuity

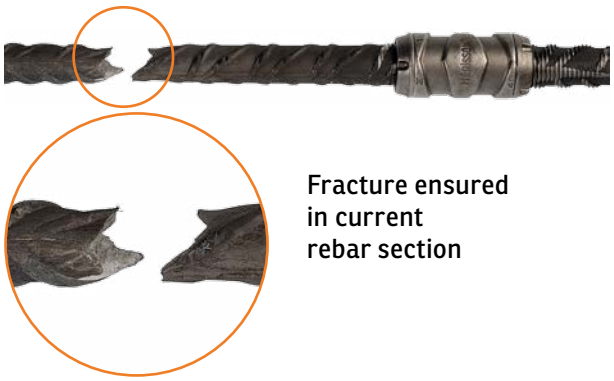
The rebar fixers' dream is to ultimately achieve the performance of an uninterrupted reinforcement. When using the Hérisson® rebar couplings, the safety of the mechanical splices are guaranteed by the full continuity of the rebar. Concrete is at least reinforced on its whole length!

Bonding continuity

With the exception of Hérisson®, couplers have a smooth finish, creating a discontinuity in the bonding properties of the rebar. Without bonding, however, the coupler concentrates stresses and weakens the liaison. This problem is intensified when the density of steel is increased. On structures which are heavily reinforced, couplers are often concentrated in the same area. The Hérisson® coupler has profile patterns on its surface. Bonding does not therefore stop at the bar, a property which is essential for reinforced concrete.

Mechanical continuity

Hérisson® technical features (thread rolling following cold upsetting of rebar, coupler forged in high-tensile steel, locknuts to compensate for any clearance in threads) contribute to obtain an extremely high level of resistance.



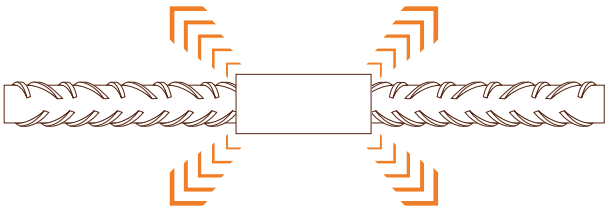
Fracture ensured
in current
rebar section

Dimensional continuity

The overall dimensions of the coupler must allow to place it even inside the most congested reinforcement sections.
The coupler has reduced longitudinal dimensions making it easy to integrate in the preparation of rebar drawings. The reduced radial dimensions enable covering without displacing the rebar layers towards the neutral axis, thus avoiding over-consumption of steel.

Continuity in shape

Shape transition from the bar to the coupler must be progressive. In order to avoid stress concentration in the concrete, right angles must be avoided. Thanks to their specifically designed locknuts, this is perfectly achieved by the Hérisson® rebar mechanical splices.



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Maximum safety

Providing rebar couplers that offer maximum safety requires specific choices with respect to design and manufacturing of every single component of our constructive system.

Coupler fabrication

Hérisson® couplers are the only couplers fabricated by **forging**, a technique that maintains the steel fibres, which ensure improved coupler resistance in the event of severe stress.

Tests

Rebar fracture	X
Tenth of mm *(NF A 35-020)*	X
Impact	X
Earthquake *(ISO 15835)*	X
Fatigue	X

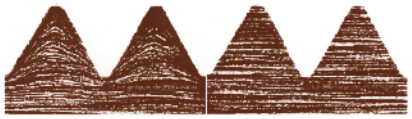
Rebar threading

Threading is performed after having increased the diameter of the rebar's edge by upsetting.

Threading by **rolling** maintains the steel fibres, which ensure the mechanical splice has excellent resistance. Rebar resistance and ductility are therefore not affected by the threading operation.

- specific geometry design
- specific patented machinery
- strict inspections
- specialised workshops

1. 
2.  Cold upsetting
3.  Sizing
4.  Thread rolling



Rolled thread *fibre maintained* | Machined thread *fibre broken*

Quality assurance

A fabrication process under continuous monitoring compounded by simple and reliable assembly procedures ensure the high quality and safety of our rebar couplers, from fabrication to installation.
Our Quality System is ISO 9001-certified.

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Certifications

ISO 9001 certification of Armaturis Quality System

CARES UKAS QUALITY MANAGEMENT 1323

Products technical approvals

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CARES UKAS PRODUCT CERTIFICATION 5039
TECHNICAL APPROVAL

Evaluation and in-process testing

- In relation with our **technical approvals**, Hérisson® splices are independantly tested every 6 months.
- Above mentioned tests are complemented by our own **continuous monitoring of products** ones.
- And we also collaborate with independant laboratories in order to test our processes **beyond normative requirements**.

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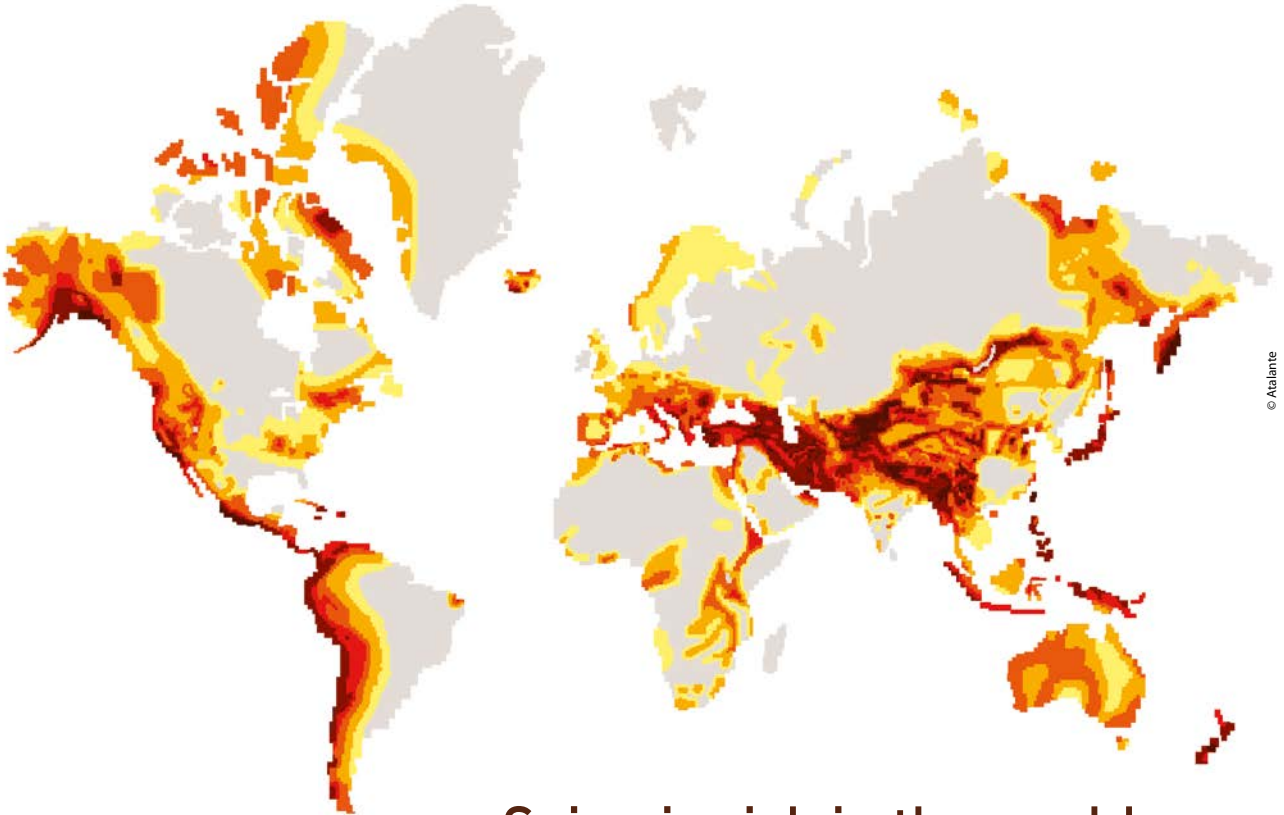
Maximum safety

“Long” locknuts and Hérisson® coupler

The Hérisson® rebar coupler, which is composed of 2 threaded bars, 1 coupler and 2 locknuts, was optimised to provide even better resistance in the event of an earthquake.

The locknuts do not affect the liaison's tensile strength (test NF 35020 et choc.). However, in the situation of the seismic test as described by the international norm, ISO 15835, the applied cycles include phases of compression during which, the locknuts are directly involved in the minimisation of the extension (of the fissuring). For the construction of civil engineering structures, which need a strong resistance in the event of an earthquake, we recommend our new generation of locknuts: the ‘long locknuts’. The combination of these long locknuts and the Hérisson® coupler gives birth to a liaison, capable of resisting every kind of earthquake.



Seismic risk in the world

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Seismic test

The oligocyclic test, or seismic test, following the ISO 15835 standard

The Hérisson® couplers have successfully passed the seismic test (oligocyclic test). As described by the ISO 15835 standard, this test is considered by specialists to be the most challenging test for rebar couplers.

The test consists of two phases, each one corresponding to the model of a particular type of earthquake.

20 x

-50 % fy ⇕ (90 % fy)

1. The moderate earthquake model

The structure must stay usable after the earthquake.

Tension/compression cycles are applied to the spliced rebar. The tension/compression stresses never go beyond the yield strength of the steel used for the bars.

A reference bar doesn't present any permanent deformation when tested in these conditions.

The test consists in a series of 20 cycles alternating tension up to 90% of the fy (yield strength) value and compression down to 50% of the fy value. The deformation of the splice is recorded during all cycles.

The acceptance criteria is a moderate deformation (less than 0,3 mm) after the test, proving the sustainability of the reinforced concrete structure.

4 x

-50 % fy ⇕ (2 □ +5 □)

2. The violent earthquake model:

The structure must remain usable during the earthquake.

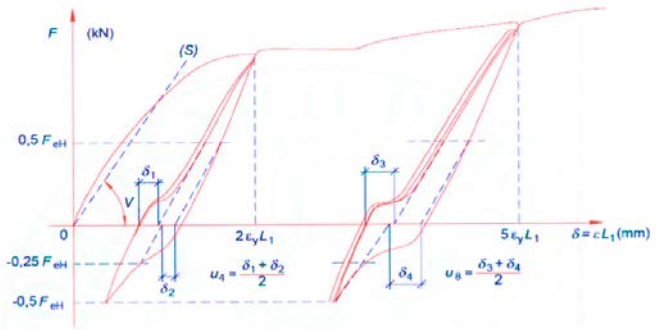
Tension/compression cycles are applied to the spliced rebar, but this time the tension stresses applied are beyond the yield strength of the steel used for the bars.

A reference bar shows a permanent elongation when tested in these conditions.

8 cycles alternating tension beyond the fy value and compression down to 50% of the fy value are applied, during which the deformation of the splice is recorded.

The acceptance criteria is the minimization of the deformation during the test in order to avoid ruining the reinforced concrete structure during an earthquake.

At the end of each test (each cycle), although it isn't required by the ISO 15835 standard, the rebar is loaded until failure in tension. Even after heavy cyclic solicitations, all the tests show that the rebar breaks outside the spliced area. Even after a series of cycles of tension/compression, the Hérisson® rebar splice remains more resistant than the bar itself.



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Fatigue resistance test

Millions of cycles without breaking

We commissioned independant laboratories specialised in testing of passive and prestressing reinforcement for concrete to confirm the fatigue resistance characteristics of Hérisson® rebar splices.

Testing

Tests were conducted on the SI PLAN hydraulic test bench, which offers 2 power ranges:
15-180 and 25-270 kN.

Two parameters are identical for all samples tested:
- Force variation sinusoidal signal frequency: 15 Hz,
- Minimum stress value: 200 N/mm².

We retained 200 MPa as the **minimum stress**, thereby providing us with a minimum stress range of 100 MPa, which exceeds the 80 MPa stress range provided as an example in French Standard NF A 35-020.

With regard to the **maximum stress** (defining the stress range in conjunction with the minimum stress), two different values were selected for each diameter:

- A first intentionally high value (325 to 360 MPa depending on diameter) to try to establish the maximum stress, at which Hérisson® couplers resist 2 x 10^6 stress cycles
- A second lower value (300 MPa), at which one of the two tests was continued beyond the 2 x 10^6 stress cycles to try to establish the maximum number of cycles reached by Hérisson® couplers within this stress range.

Summary of testing conditions and results

Diameter	Stress range (MPa)	2 x 10^6 cycles achie-vement	No. of cycles reached (x10^6)	Test stoppage conditions
40	100 (200-300)	Yes		Intentional stoppage, sample intact
32	125 (200-325)	1,975		Bar thread fracture
	100 (200-300)		4,87	Bar thread fracture
25	160 (200-360)	Yes		Intentional stoppage, sample intact
	100 (200-300)		6,31	Intentional stoppage, sample intact
20	160 (200-360)	Yes		Intentional stoppage, sample intact
	100 (200-300)		5,00	Intentional stoppage, sample intact

Conclusion

The fatigue test results for the Hérisson® couplers are very satisfactory since they broadly exceed the minimum requirements of French Standard NF A 35-020.
- **Over 5 million cycles without failure under 300 MPa maximum stress and a 100 MPa stress range.**
- **Over 2 million cycles without failure under 360 MPa maximum stress and a 160 MPa stress range.**

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The range

Hérisson+®

Hérisson+® mono

Long locknuts

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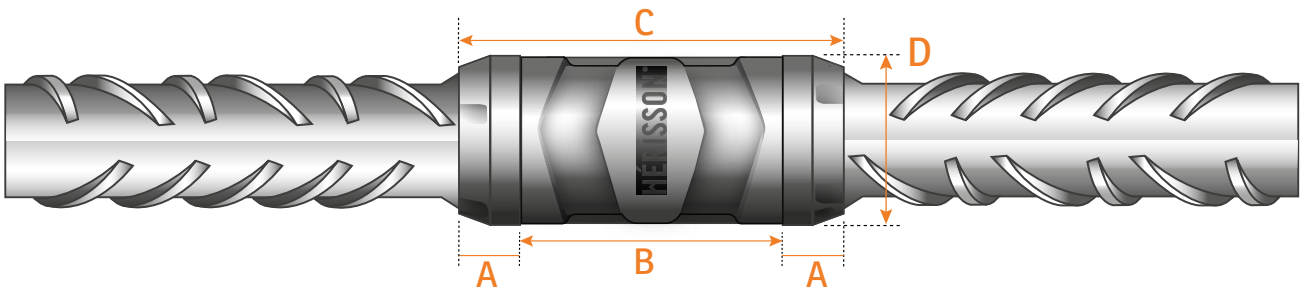
The + range

Hérisson+® and long locknuts



Hérisson+® coupler and long locknuts specifications

	Ø12	Ø14	Ø16	Ø20	Ø25	Ø32	Ø40
A=locknut width (mm)	10.00	10.00	11.50	14.00	17.50	21.00	26.50
B=coupler length (mm))	36.00	36.00	44.50	52.85	65.65	77.50	96.50
C=total length (mm))	56.00	56.00	67.50	80.85	100.65	119.50	149.50
D=overall diameter (mm)	23.10	23.10	27.90	33.70	42.30	51.00	63.40
Locknut ref.	FRL12	FRL14	FRL16	FRL20	FRL25	FRL32	FRL40
Coupler ref.	CHP12	CHP14	CHP16	CHP20	CHP25	CHP32	CHP40
Colour codes							

Hérisson+® model
+ long locknuts

Maximum safety

Description of the Hérisson+® transitional splices

Thanks to the upsetting performed before threading, the Hérisson® system allows to easily splice 2 rebars of different diameters. This is simply achieved by using the coupler and locknuts the diameter of the small bar to be spliced.

larger bar diameter (mm)	coupleur ref.	locknuts ref.	smaller bar diameter (mm)
Ø40	CHP32	FRL32	Ø32
Ø32	CHP25	FRL25	Ø25
Ø25	CHP20	FRL20	Ø20
Ø20	CHP16	FRL16	Ø16

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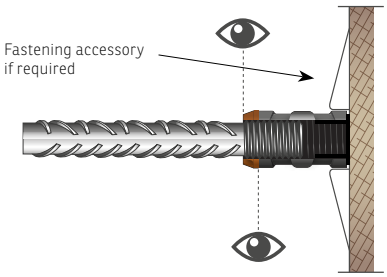
Standard assembly

The 2nd phase rebar can be screwed in

Installation

Step 1: 1st phase installation

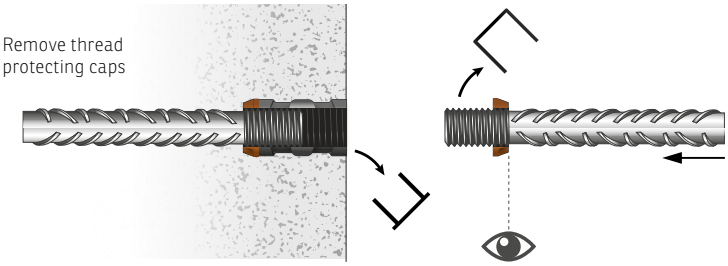


Inspection

- [X] The locknut No. 1 is tightly screwed on the rebar.
- [X] The coupler is completely screwed against the locknut No. 1.
- [X] The cap is correctly in place on the coupler.

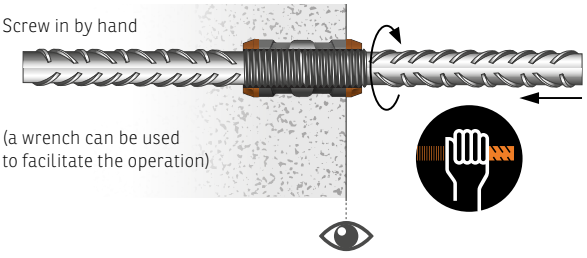
1st phase concreting

Step 2: put 2nd phase rebar in position



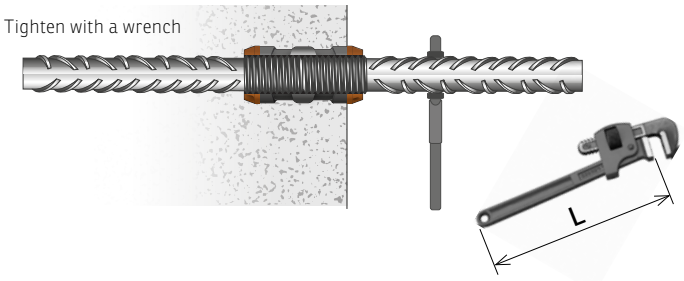
- [X] The locknut No. 2 is tightly screwed on the 2nd rebar.

Step 3: screw on 2nd phase rebar



- [X] Upon completion of screwing, the locknut No. 2 is completely screwed against the coupler.

Step 4: secure the screwing



- [X] For dia. 25 and above: L ≥ 0.80 m.

At this stage of assembly the Hérisson+® rebar coupler guarantees the safety of the splice.

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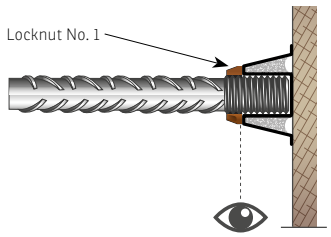
Position assembly

The 2nd phase rebar cannot be screwed in

Installation

Step 1: 1st phase installation

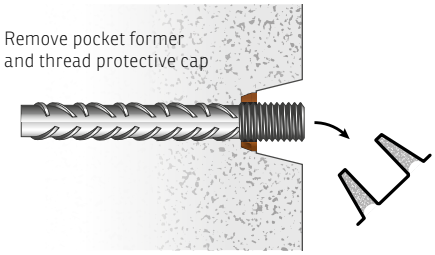


Inspection

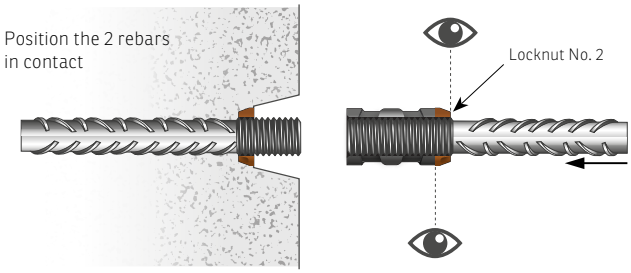
- [X] Locknut No. 1 is tightly screwed on the rebar.
- [X] Thread protective cap and notch former are positioned correctly.

1st phase concreting

Step 2: remove notch former

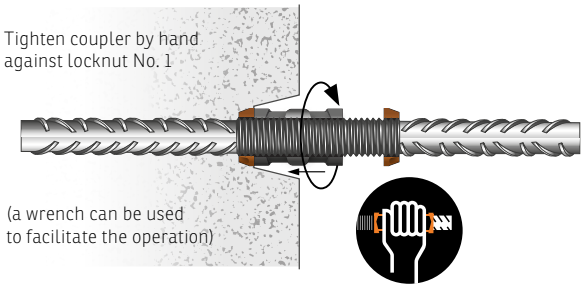


Step 3: 2nd phase installation



- [X] Locknut No. 2 is tightly screwed on the rebar.
- [X] The coupler is completely screwed against locknut No. 2.

Step 4: assembly by rotating the coupler



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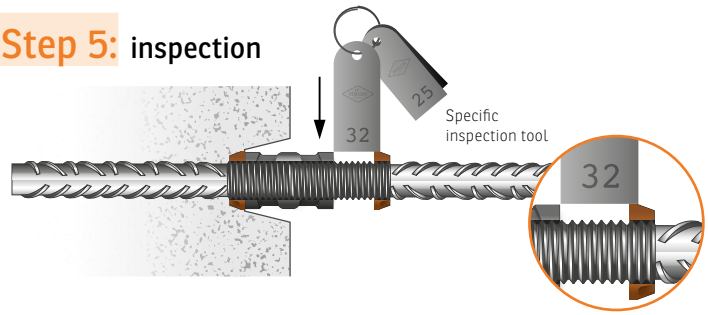
Position assembly cont.

The 2nd phase rebar cannot be screwed in

Installation

Step 5: inspection



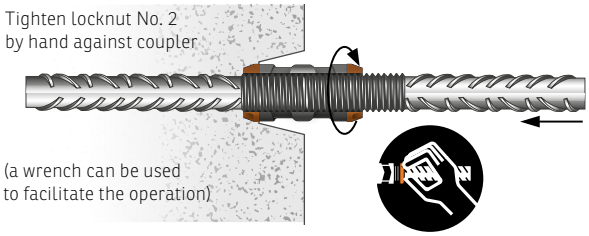
Inspection

X The specific inspection tool must not enter between the coupler and locknut No. 2.

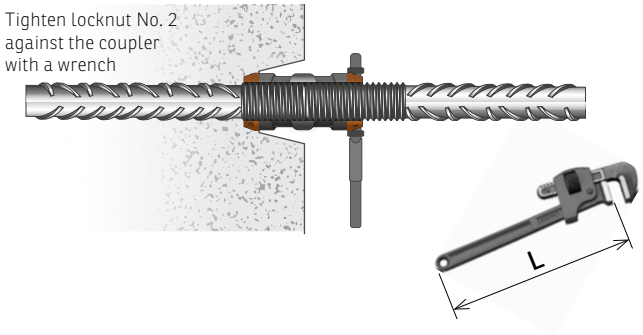
The specific inspection tool makes so easy to check the splice assembly and therefore its safety.

Possible orientation of bent bar

Step 6: tighten locknut No. 2



Step 7: secure the screwing



X For dia. 25 and above: L ≥ 0.80 m.

At this stage of assembly the Hérisson+® rebar coupler guarantees the safety of the splice.

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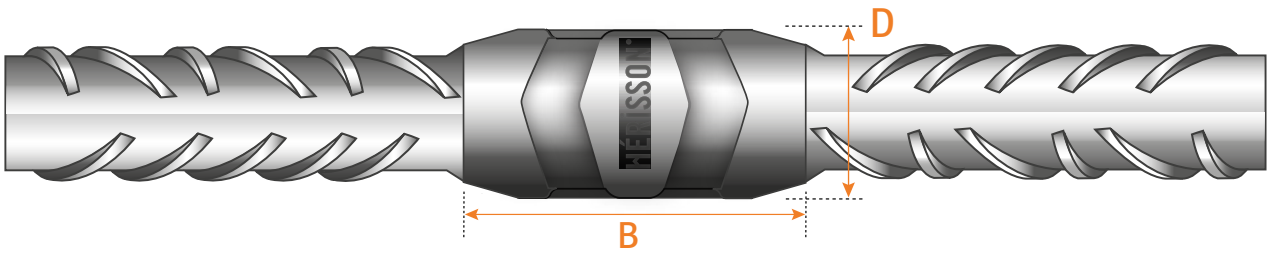
The mono range

Hérisson+® mono



Hérisson+® mono coupler specifications

	Ø12	Ø14	Ø16	Ø20	Ø25	Ø32	Ø40
B=coupler length (mm)	48.00	48.00	59.50	70.85	87.65	103.50	128.50
D=overall diameter (mm)	23.10	23.10	27.90	33.70	42.30	51.00	63.40
Coupler ref.	CMO12	CMO14	CMO16	CMO20	CMO25	CMO32	CMO40
Colour codes							

Hérisson+® mono model

Description of the Hérisson+® mono transitional splices

Thanks to the upsetting performed before threading, the Hérisson® system allows to easily splice 2 rebars of different diameters. This is simply achieved by using the coupler and locknuts the diameter of the small bar to be spliced.

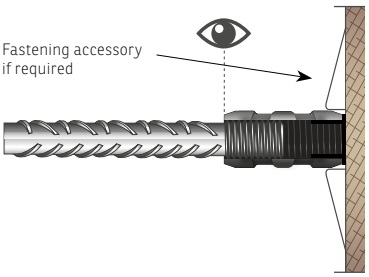
larger bar diameter (mm)	coupleur ref.	smaller bar diameter (mm)
Ø40	CMO32	Ø32
Ø32	CMO25	Ø25
Ø25	CMO20	Ø20
Ø20	CMO16	Ø16

Hérisson+® mono standard assembly

The 2nd phase rebar can be screwed in

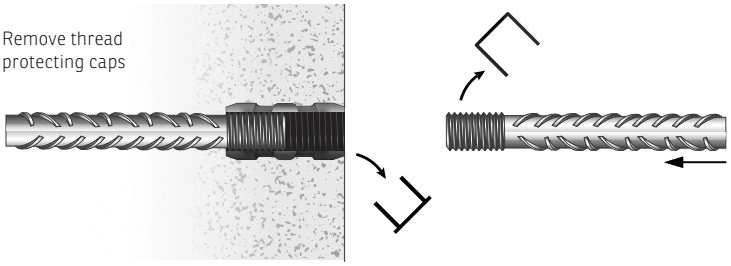
Installation

Step 1: 1st phase installation

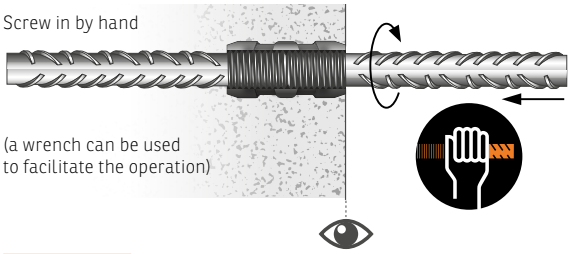


1st phase concreting

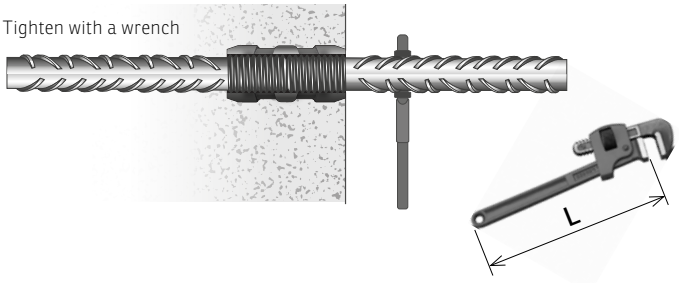
Step 2: put 2nd phase rebar in position



Step 3: screw on 2nd phase rebar



Step 4: secure the screwing



Inspection

[X] The coupler is tightly screwed on the rebar.

[X] The plug is correctly inserted inside the coupler.

[X] For dia. 25 and above: L ≥ 0.80 m.

At this stage of assembly the Hérisson+® mono rebar coupler guarantees the safety of the splice.

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References

Power - Nuclear

Description	General contractor	Project owner
Jules Horowitz material testing Reactor	AREVA TA	CEA Cadarache
TDC Project, Aldermaston	AWE	AWE
La HAGUE EEVLH interim storage building	SGN	AREVA NC
Pegasus Main Works Ph.1 & 2	AWE	AWE
Cementation/handling building	EGIS	CEA Marcoule
ITER experimental fusion power plant	VFR	F4E
EPURE building	CBR - NUVIA	CEA Valduc
Ultimate Emergency Diesel Units	CBN	EDF

Power - Hydraulic

Corsica Rizzanese dam	EDF CIH	EDF
New Chatou dam	Coyne et Bellier	Voies navigables de France

Commercial & Residential

Cannes St Cassien"AQUAVIVA" sewage treatment plant	SAFEGE/cabinet MERLIN J.V.	Lyonnaise des Eaux France
Marseille "Terrasses du Port" shopping mall	Atelier Aquitain d'architectes associés (4A)	Hammerson Les Terrasses du Port SCI
Paris - Batignolles thick slabs	OGI	Paris Batignolles Aménagement
London Bloomberg european headquarters	Sir Robert McAlpine	Bloomberg
St Raphael harbour	ACRI-IN	Régie des Ports raphaëlois
Lyon "Stade des Lumières" football stadium	Populous	Foncière du Montout
Battersea Power Station Development Phase 1	CARILLION	Battersea Holding Co. Ltd.
Shepherd's Bush Westfield Phase 2	Westfield Europe	Westfield London
Northern Dock Car Park	EIFFAGE TP	Principality of Monaco
New Cambridge R&D Center & Headquarters	SKANSKA	AstraZeneca
Wimbledon Courts 1 & 19	Sir Robert McAlpine	AELTC
ARIANE 6 ELA4 launch complex	EIFFAGE GC Eclair6	CNES

Roads & Railways

East european high speed railroad – section G phase 2 lot 41	INEXIA/ARCADIS	RFF
Verdun sur Garonne suspension bridge	EGIS JMI	SPVG (Sté du pont de Verdun sur Garonne)
Bergerac Dordogne viaduct	ARCADIS ESG	Conseil général de la Dordogne
South european high speed railroad lots 12 to 15	COSEA	LISEA
Brittany – Pays de la Loire high speed railroad lots F & G	SETEC	Eiffage Rail Express SAS
Crossrail Paddington station	SKANSKA-COSTAIN JV	CROSSRAIL
Nouvelle Route du Littoral	GTOI	Réunion Island Council
Douala 2nd Bridge over the Wouri	SOLETANCHE BACHY	Cameroun government
Stepney Green & Limmo shafts	DRAGADOS	CROSSRAIL

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