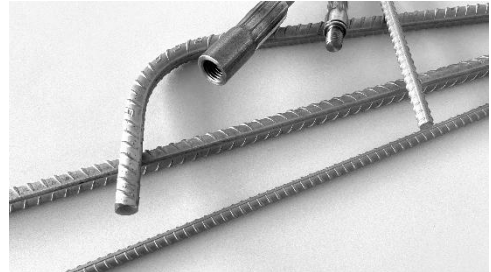


# Product data sheet Re-bar 10 & 16

«Ribbed VSL Memory®-Steel Re-bars for structural strengthening»

VSL Memory®-Steel Re-bar 10 and 16 is used in various areas of structural reinforcement (for concrete and masonry).

The Re-bars are pre-strained during factory production. After being anchored in the concrete, they are heated to induce prestressing. In their final state, the Re-bars are fully embedded in a system-approved repair mortar, specifically R3/R4 class mortar as per EN 1504, which is designed for structural repairs.



Once installed, the Re-bars function as internal prestressing with bond. To ensure fire and corrosion protection, the minimum dimensions of the structural components and concrete coverings must comply with local standards and regulations.

Material Properties	Maximum tensile strength	Design value tensile strength	Elongation at break	Elastic modulus (for calculation)*
Re-bar 10 & 16	>700 N/mm <sup>2</sup>	520 N/mm <sup>2</sup>	20%	70 kN/mm <sup>2</sup>

\* After heating/activation the elastic modulus is 160 kN/mm<sup>2</sup> up to a stress increase of 50 N/mm<sup>2</sup>, after which it decreases to 70 kN/mm<sup>2</sup>. This value is used for calculations.

Product data	Nominal diameter	Cross-section	Weight	Design value of tensile force
Re-bar 10	10.7 mm	89.9 mm <sup>2</sup>	0.71 kg/m	46.7 kN
Re-bar 16	16.5 mm	211.2 mm <sup>2</sup>	1.67 kg/m	109.8 kN

Prestressing	Heating temperature	Prestress $t_0$	Prestressing force $t_0$	Prestressing force $t_{\infty}$ *
Re-bar 10	200°C (only electricity)	350 N/mm <sup>2</sup>	31.5 kN	26.8 kN
	≥300°C (gas torch or electricity)	400 N/mm <sup>2</sup>	36.0 kN	30.6 kN
Re-bar 16	200°C (only electricity)	260 N/mm <sup>2</sup>	54.9 kN	46.7 kN
	≥300°C (gas torch or electricity)	320 N/mm <sup>2</sup>	67.6 kN	57.5 kN

\*Relaxation of initial prestress after  $t = \infty$  (50 years) is 15%

Geometrical specification	Bending radius	Min. length of end hook	Diameter drilling hole	Outside diameter screw coupler
Re-bar 10	≥40 mm (Ø80 mm)	100 mm	≥14 mm	21 mm
Re-bar 16	≥50 mm (Ø100 mm)	150 mm	≥20 mm	30 mm

### When to choose Re-bar?

- Changes to the structural system
- Increase of ultimate and/or service loads
- New standard requirements

### Applications:

- Flexural strengthening of concrete structures
- Shear strengthening of concrete beams
- Confinement of silos or big columns
- Increase of reinforcement against punching shear
- Earthquake strengthening of masonry

### Advantages:

- Active, immediately load-bearing (prestressing)
- High ductility (joint formation and force redistributions remain possible. No embrittlement.)
- Robust anchoring in the core concrete
- Minimal space requirements
- Corrosion and fire protection by mortar overlay/concrete cover
- Increased serviceability of structure
- Reduction of deflections and crack opening
- Stress relief of the internal reinforcement

### Appearance:

Product is ribbed Re-bar with screw coupler, metallic dark grey colour.

### Remark screw couplers:

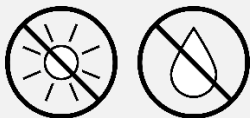
Due to manufacturing constraints, Re-bar is produced solely in the form of straight bars. The bars are pre-stressed at the factory and fitted with screw couplers on both ends. They are then screwed together in sequence and cut to the specified project lengths, ensuring no waste is generated.

### Forms of delivery:

- Assembled, cut to length and, if required, bent in accordance with project specifications at the factory.
- As bundles of 8 units Re-bar 16 or 20 units Re-bar 10 (bar length approx. 5.80 m / Cutting, bending and coupling carried out directly on site by contractor.

### Storage/transport:

VSL Memory®-Steel Re-bars must be stored and transported in a dry, protected environment (no mechanical or chemical damage, etc.). Condensation water (due to varying ambient temperatures and conditions) must be prevented by suitable storage and ventilation. Road transport must be carried out in closed trucks to prevent possible contamination by de-icing salts. The material must be protected from direct sunlight and temperatures above 40°C until it is installed and activated.



#### Attention:

Products must always be protected from exposure to direct sunlight, higher temperatures, or humidity.



#### Storage:

Max: 40°C / 104°F  
Min: 5°C / 41°F

## General information

### Condition of the substrate

The concrete substrate must be capable of transferring loads and must exhibit a compressive strength exceeding 25 N/mm<sup>2</sup> (equivalent to C20/25 as per EN 206-1). Any damaged or chloride-contaminated concrete must be removed using hydromechanical jetting or appropriate mechanical methods such as picking, chipping, or sandblasting.

The substrate must then be roughened, cleaned, and wetted in accordance with the specifications provided in the mortar supplier's data sheet. Additionally, the concrete substrate must achieve a minimum tensile adhesion strength of 1.5 N/mm<sup>2</sup> (as defined in EN 1542).

### Information on designing

#### Corrosion protection:

Prestressing steels are susceptible to stress corrosion cracking, particularly in environments with high humidity, chlorides, salts, or acids. To mitigate this risk, rebar is embedded in a cementitious matrix, which provides a protective alkaline environment for internal reinforcement and acts as a barrier against chloride ion penetration.

The thickness of the mortar cover is determined based on standard specifications and the exposure class (as per EN 1992-1-1).

#### Fire protection:

VSL Memory®-Steel Re-bars reacts to fire similarly to conventional steel, losing most of its strength at temperatures above 400°C and all prestress at around 350°C. If the minimum concrete element dimensions and cover thickness meet local standards, fire protection is typically assured.

If the mortar layer's fire resistance is insufficient, it can be improved with additional fire protection overlays. The fire protection measures and layer thicknesses must comply with local regulations and standards.

#### General notes:

- Re-bars shall be interconnected using screw couplers. The space requirements for these couplers, including their external dimensions (as detailed in the table on page 1), must be considered during the design process.
- If required, small reinforcing bars or metal screw hooks may be utilized for the fixation or positioning of Re-bar. Third-party products or plastics shall not be used, as they may melt during application, posing risks to the applicator. Furthermore, toxic or aggressive decomposition products may be released upon heating.
- Construction foam and other chemicals are prohibited for shuttering formwork or fixings (aggressive decomposition products when heated). If already present on the structure in the area of the reinforcement work, these must be removed, and the substrate must be cleaned.
- When Re-bar is laid on a curved substrate, it shall be ensured that the Re-bar is levelled during activation with gas. Prior to installation, the evenness of the substrate must be verified.

#### Engineering support:

For questions or uncertainties, VSL offers support in project planning, assistance with structural design, cost estimations and tenders.



## Application and installation protocol

### Handling and Installation Guidelines

Detailed instructions for the handling and installation of our products can be found in the current method statement and the regulations provided by the system-approved mortar supplier.

### Environmental and Substrate Conditions

Key parameters such as substrate temperature, air temperature, substrate moisture content, and other relevant factors are specified in:

- The product data sheets of the mortar used.
- Local standards and regulations.

### System-approved products

The VSL Memory®-Steel Re-bar system has been tested and approved in combination with R3 and R4 class mortars for structural repairs, as per EN 1504. Please contact the local VSL office for more detailed information and advice on the system-approved supplementary products.

Product	Description
Re-bar 10 & 16	The Ø10 and Ø16 ribbed Re-bar made of memory®-steel is used for structural reinforcement of concrete structures (for components subjected to static or dynamic loads). re-bar is delivered pre-strained
*	2-component epoxy high performance chemical <b>anchoring adhesive</b>
*	Shrinkage-compensated, class R4 repair mortar <b>for horizontal application</b>
*	Shrinkage-compensated, class R4 repair mortar <b>for horizontal, vertical, and overhead application</b>
*	Shrinkage-compensated, class R4 wet <b>sprayed mortar for vertical and overhead application</b>
*	Shrinkage-free, class R4 precision <b>grouting mortar for filling formwork or cut groove</b>
*	Cement mortar for sealing surface cracks
*	Very fine cement-based crack injection mortar (after surface sealing)
*	Bonding primer and corrosion protection (3-component cementitious epoxy) for re-bar and internal reinforcement
*	Dry-mix sprayed mortar (cementitious, alkali free) for tunnelling overhead and vertically

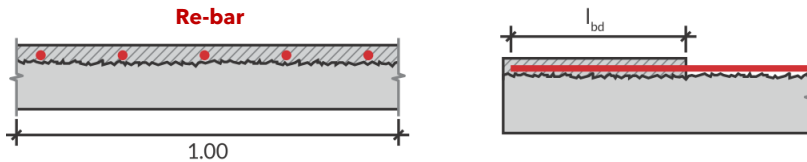
Detailed information on the products is provided in the corresponding product data sheets.

### End anchoring of Re-bar

To effectively transfer the prestressing force, the Re-bar is anchored at the end zones. In standard applications, grouting is performed in the middle section after prestressing. Alternatively, the Re-bar can be fully grouted first and subsequently activated at the free ends using electric heating.

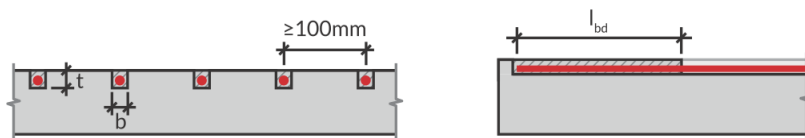
### A) VSL Memory®-Steel Re-bar in reprofiling mortar:

To calculate the anchorage length  $l_{bd}$ , the initial prestressing force of Re-bar is transferred to the substrate via the mortar bond of  $>1.5 \text{ N/mm}^2$  (tensile adhesion value of the concrete with a minimum compressive strength of  $25 \text{ N/mm}^2$ ). VSL recommends reducing the anchoring resistance with a safety factor of  $>1.5$ . Special attention should be taken for proper substrate preparation.



### B) VSL Memory®-Steel Re-bar in the concrete groove:

The anchorage lengths for the prestressing force of Re-bar in the groove refer to tests at Empa Switzerland. The test results were reduced by a safety factor of 1.5. The minimum axial spacing of the grooves is 100 mm. For smaller spacing, the system with reprofiling and spraying mortar can be used.



This results in the following data for rebar:

Product	Width of groove b	Min. depth of groove t	Min. anchorage length $l_{bd}$
Re-bar 10	25 mm	25 mm*	400 mm**
Re-bar 16	30 mm	30 mm*	600 mm**

\* Groove depths and corresponding mortar covers should be increased, if necessary, to comply with national standards and reach project-specific requirements on corrosion and/or fire protection. The grooves can be "over-profiled" for additional protection, if required.

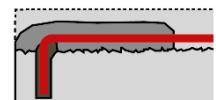
\*\* reduced by safety factor of 1.5

The corresponding research report (2021-003/SNSF 200021\_175998 / English) is available on request. It is possible to reduce the anchorage length for concrete of higher qualities, after verification from VSL technical department.

### C) Use of end hooks:

The anchorage can be designed more robust by bending end hooks onto the Re-bar and anchoring them into drilled holes. The forces are thus transferred to the core concrete. Geometric details can be found in the tables on the first page.

The end hooks are either glued in with the system-approved anchoring adhesive (dark grey area in illustration) or embedded in the grouting mortar accordingly (diameter of drilled holes must be increased). Mortar shall be applied above the drilled hole over a length of  $>100 \text{ mm}$ , which serves as heat protection for the adhesive and as a support bed for the Re-bars.



### D) Use of additional stirrups:

Due to the limited web widths of concrete beams, the prestressing force of Re-bar cannot always be properly anchored only by shear bond. To prevent delamination of the mortar layer, it is recommended to enclose the Re-bar with shear stirrups made of standard structural steel, providing additional suspension.

### Installation of Shear Stirrups

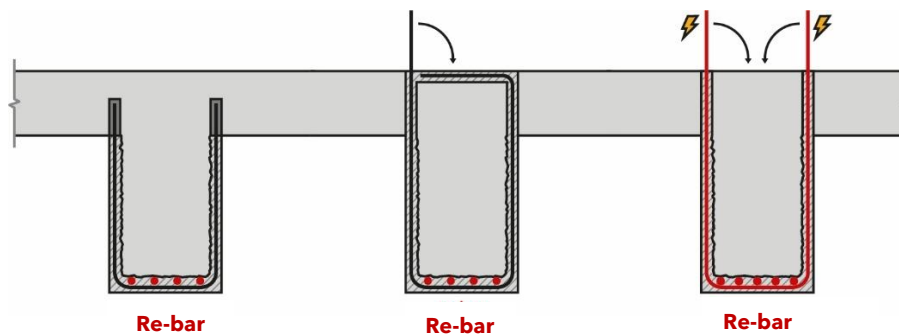
The stirrups can be anchored in the compression zone of the girder using one of the following methods:

- Drilling into the web and securing with anchoring adhesive.
- Drilling through the web to create a closed stirrup, embedded in grouting mortar.

### Alternative Bracing Method

Bracing can also be achieved using prestressed Re-bar 10 U-stirrups. The application of prestressing considers following:

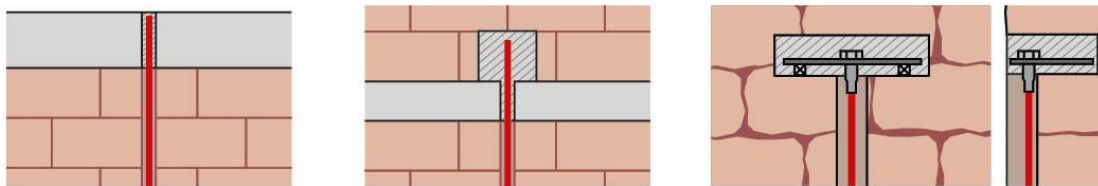
- Relieves the existing internal reinforcement.
- Actively compresses the connection surface between the new mortar layer and the existing concrete, enhancing bond integrity.



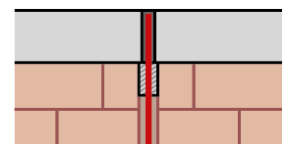
### E) VSL Memory®-Steel Re-bar in masonry structures:

For seismic strengthening of masonry, a controlled, vertical compressive force is applied to the wall. Re-bar must be anchored in the concrete (ceiling and floor slab). It is also possible to subsequently cast concrete bases to anchor Re-bar.

For concrete slabs with thickness <math><200\text{ mm}</math>, it is recommended to install additional anchoring above and/or below the ceiling using mortar blocks. In certain situations, screw couplers can also be pressed onto Re-bar to connect them to steel plates as anchoring.



VSL Memory®-Steel Re-bar is embedded in the drilled hole using system-approved grouting mortar. If the Re-bar is bonded using the system-approved high-performance epoxy adhesive, the adhesive (dark grey area in illustration) must also be protected against heat using a mortar bed (hatched area in the sketch).



### Engineering support:

The engineering team of VSL will be happy to assist you with the design.



## Activation of prestressing

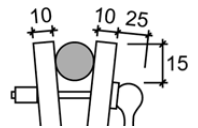
### Heating with gas:

To activate with the gas burner, Re-bar is heated evenly to 300°C in sections length of approx. 1.00 m. The process must be supervised by a second person for temperature verification procedure and recording into the Re-bar heating form.

### Electric resistive heating:

When activating Re-bar using electric resistance heating, the temperature is increased to 200°C if the Re-bar is fully embedded in concrete or mortar. If the Re-bar is only anchored at the ends, electric heating can also be used as an alternative to a gas flame. In this case, the temperature may be raised to 300°C for effective activation.

Contact between Re-bar and the internal reinforcement or conductive parts is prohibited. Plastic bolts and clips are used for fixing/positioning of the Re-bars. It is also important to ensure that there is sufficient space for the copper clamps required for electrical contact.



The contractor must organise the necessary electric power connection on site. However, the requirements must be noted in an implementation plan by the planner.

Required power supply:

either **2-times** connection 3x400 V, **CEE 32A**, 400V, 5-pole

or **1-times** connection 3x400 V, **CEE 63A**, 400V, 5-pole

All the necessary processing equipment for heating and temperature control can be purchased or rented from the manufacturer. The local VSL office can provide you with further details.

## Approvals and Test Reports

- Ema, Dübendorf (CH): Tensile tests with strain measurement (with and without coupler) – Test report No. 5214026175, 2020 and No. 5214028735, 2022
- Empa, Dübendorf (CH): Activation and stress-relaxation of memory-steel (Fe-SMA) 're-bar' – Test report No. 5211.00688.100.01-2b, 2018
- Research report 2020-001 (CTI Project No. 18528.1 PFIW-IW): Iron-based Shape Memory Alloys as Shear Reinforcement for Civil Structures, 2020
- Research report 2021-002 and -003 (SNSF 200021\_175998): Iron-based Shape Memory Alloy Bars for Flexural Strengthening of Concrete – bond tests, 2021
- Research report 2021-004 (SNSF 200021\_175998): Iron-based Shape Memory Alloy Bars for Flexural Strengthening of Concrete – Beam tests, 2021

Further test reports and technical documentation are available on request.

## Notes

All technical values in this product data sheet are subject to the VSL quality assurance and are based on laboratory tests. Contact us if you have any questions about the tests performed. Current measured values may deviate from the product specifications. For design purpose, VSL provides engineering support and advice. For further information please visit us at [www.vsl.com](http://www.vsl.com) or contact our local representative directly.

The information in this product data sheet is valid for the corresponding product delivered by VSL. Please note that the data may differ in other countries and please refer to the local product data sheet abroad. The information and data in this technical data sheet are intended to ensure that the product is considered for normal use and is based on our knowledge and experience. However, they do not release the user from the obligation to check the suitability and use of the product on his own responsibility.

Product specifications are subject to change without notice. In all other respects, our terms and conditions of sale and delivery shall apply. The latest product data sheet shall apply.