Product data sheet re-bar 10 & 16

«for statically and dynamically loaded elements»

The ribbed memory®-steel re-bar 10 and 16 is used in various areas of structural reinforcement (for concrete and masonry).

The bars with a maximum delivery length of approx. 5.8 m are connected using screw couplers and installed with the desired length. After its anchoring to the concrete base, re-bar is heated/prestressed. In its final state, re-bar is fully embedded in Sika repair mortar.

The bars act as internal prestressing with bond. Minimum component dimensions and concrete covers in accordance with the local standards are required as protection against the effects of fire.

Material properties	Max. tensile strength	Design value tensile strength	Elongation at break	Modulus of elasticity (for calculation)*
re-bar 10 & 16	>700 N/ mm²	520 N/ mm²	20%	70 kN/mm²

*After heating/activation the elastic modulus is 160 kN/mm² up to a stress increase of 50 N/mm², after which it decreases to 70 kN/mm². This value is used for calculation.

Product data	Nom. diameter	Cross-section	Weight	Desing value tensile force
re-bar 10	10.7 mm	89.9 mm²	0.71 kg/m	46.7 kN
re-bar 16	16.5 mm	211.2 mm²	1.67 kg/m	109.8 kN

Prestressing	Heating temperature	Prestress t_0	Prestressing force t_0	Relaxation
re-bar 10	200 °C (Electricity)	350 N/mm²	31.5 kN	15 % t_∞
	300 °C (Gas)	400 N/mm²	36.0 kN	15 % t_∞
re-bar 16	200 °C (Electricity)	260 N/mm²	54.9 kN	15 % t_∞
	300 °C (Gas)	320 N/mm²	67.6 kN	15 % t_∞

Geometrical specification	Bending radius	Min. length of end hook	Diameter drilling hole	Outside diameter screw coupler
re-bar 10	>40 mm	150 mm	≥14 mm	21 mm
re-bar 16	>50 mm	150 mm	≥20 mm	30 mm

Advantages:
- Easy-to-install flexural and shear reinforcement of reinforced concrete
- Active and immediately load-bearing reinforcement (prestressing)
- High ductility (joint formation/force redistribution possible)
- Robust anchoring in the core concrete
- Minimal space requirements
- Corrosion and fire protection by mortar/concrete covering
- Increases the service life of the structure
- Reduction of deflections and crack opening
- Increased serviceability
- Stress relief of the internal reinforcement
- Simple seismic strengthening of masonry

Appearance:
Ripped rebar with screw coupler, metallic dark grey

Storage/transport:
re-bar must be stored and transported in a dry, protected place (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.

Information

Condition of the substrate

The concrete substrate must be able to transfer the load and must have a compression strength of >25 N/mm^2 (C20/25 acc. to EN 206-1). Damaged or chloride-contaminated concrete is removed by hydromechanical jetting or by adequate mechanical picking/chipping (see method statement) and sandblasting. The substrate needs to be roughened, cleaned, and wetted according to available specifications in the data sheet of the mortar supplier. A minimal tensile adhesion strength of the concrete substrate of 1.5 N/mm^2 is required (EN 1542). When re-bar is applied in grooves, information concerning geometry are to be found in the current re-fer method statement.

Information on designing

Corrosion protection:
The memory®-steel alloy contains about 10% chromium in mass and behaves similarly to a 1.4003 alloy according to DIN EN 10088 (corrosion resistance class I). A known risk associated with prestressing steels is stress corrosion cracking in the presence of high humidity and chlorides, other salts, or acids. re-bar is placed in a cementitious matrix, which builds a protective alkalinity for the internal reinforcement and shields against penetrating chloride ions. SikaTop® Armatec®-110 EpoCem® is applied as a bonding agent and slight corrosion protection on the re-bar and internal reinforcement. If sufficient protection cannot be guaranteed with the mortar/concrete covering, additional measures must be taken (e.g. sealing, etc.).

Fire protection:
memory®-steel has a similar reaction to fire to that of conventional steel, losing strength significantly from about 400°C, and reducing its prestressing to zero at about 350°C. If minimum concrete element dimensions and covers comply with the local standard, protection in the event of fire is generally guaranteed. If the fire protection of the mortar layer is not guaranteed, it can be further improved with SikaCem® Pyrocoat.

The fire protection measures and stated layer thicknesses are guide values and must also comply with all relevant local regulations and standards.

General notes:

- The re-bars are connected to each other using screw couplers. The necessary space requirements (external dimensions of the couplers) must be taken into account when designing.
- If necessary, small reinforcing bars or metal screw hooks are used to fix/position re-bar. Other third-party products and plastics must not be used as they can melt and pose a risk for the applicator. In addition, toxic or aggressive decomposition products may be released when heated.
- Construction foam and other chemicals are prohibited for shuttering formwork or fixings (aggressive decomposition products when heated).
- When laying re-bar on a curved substrate, ensure that re-bar is levelled when activated with gas (check for evenness of the substrate beforehand).

Application of re-bar

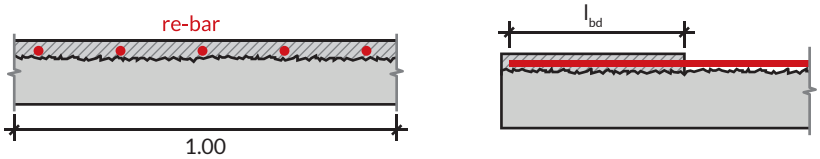
Information on the handling and the installation of our products can be found in the current re-fer method statement and the regulations of the mortar supplier, respectively. Information on substrate temperature, air temperature, substrate moisture etc. can be found in the product data sheets of the mortar used and in the local standards.

End anchoring of re-bar

To absorb the prestressing force, re-bar is anchored in the end zones during construction. After prestressing, the centre area between the anchorage zones is also filled with mortar.

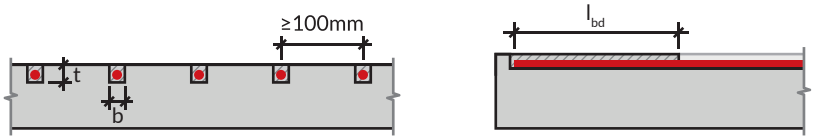
re-bar in a flat mortar layer (reprofiling/grouting mortar on the floor or sprayed mortar overhead):

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 N/mm² (tensile adhesion value of the concrete with a minimum compressive strength of 25 N/mm²). re-fer recommends reducing the anchoring resistance with a safety factor of >1.5.



re-bar in the concrete groove (on the floor or wall):

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 Sika reprofiling and spraying mortar can be used.



This results in the following data for re-bar:

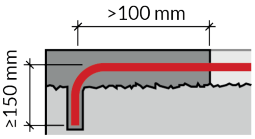
Product	Width w of groove	Depth d of groove	Design anchorages length l_{bd}
re-bar 10	25 mm	25 mm **	400 mm *
re-bar 16	30 mm	30 mm **	600 mm *

*reduced by safety factor of 1.5
**Groove depths and corresponding mortar covers should be increased, if necessary, to comply with national standards and reach project-specific requirements on corrosion- or fire protection.

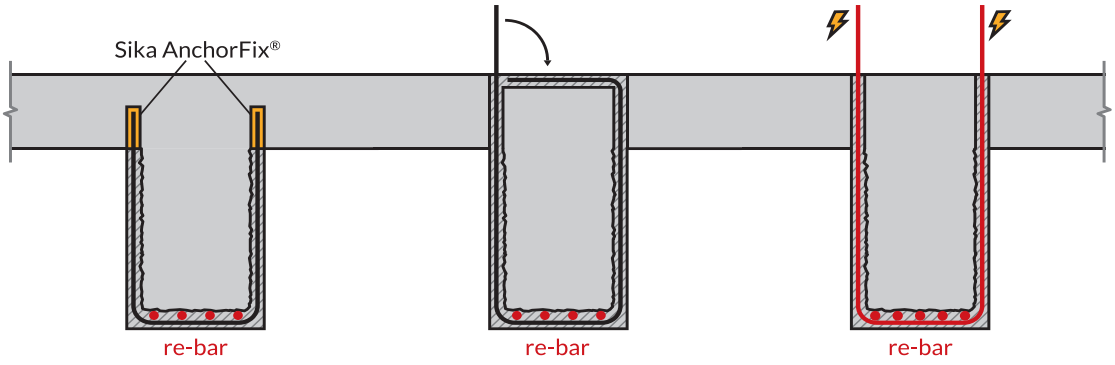
The corresponding research report (2021-003/SNSF 200021_175998 / English) is available on request. It is possible to reduce the anchorage length for concretes of higher qualities. The re-fer engineering support will assist in design questions.

Use of end hooks:
The anchorage can be rendered more robust by bending end hooks onto the re-bar and gluing/mortaring them into drill 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 Sika® AnchorFix®-3030 or grouted in with SikaGrout®-314 N. Mortar is also always applied above the drill hole over a length of >100 mm. This serves as heat protection for the adhesive and as a support bed for the bars.



Use of additional stirrups:
Due to limited web widths, the prestressing force of re-bar can often not be anchored via the pure shear bond. It is advisable to enclose re-bar with shear stirrups made of normal structural steel to prevent the mortar layer from detaching (additional suspension). The stirrups are anchored in the compression zone of the girder (drill in the web and bond with Sika® AnchorFix®-3030 / drill through the web and fill as a closed stirrup with SikaGrout®-314 N grouting mortar). For larger beams or bridge girders, bracing can also be carried out using re-bar 10 U-stirrups (prestressed). The prestressing relieves the existing internal reinforcement and over-presses the connection surface between the new mortar layer and the existing concrete. The design value of the shear bond can be increased.



re-bar in masonry:
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.

re-bar is embedded in the drill hole with SikaGrout®-314 N grouting mortar or Sika® AnchorFix®-3030 anchor adhesive. For thin ceilings <200 mm, it is recommended that additional anchoring is carried out above and below the ceiling using concrete blocks.

The technical support of re-fer can assist you with the conceptual design..

Activation of prestressing

Heating with gas:
To activate with the gas burner, re-bar is heated evenly to 300°C in sections of approx. 1.00 m length. The process must be supervised by a second person who checks the temperature and protocols it. The planning engineers can request a heating protocol.

The technical service of re-fer offers a check of the prestressing force.

Electric resistive heating:
re-bar must not come into contact with the internal reinforcement or conductive parts. Plastic dowels and clips supplied by re-fer are used for fixing/positioning. The heating can be done up to 200°C.

Required power supply:	either 2x connection 3x400 V, CEE 32A, 400V, 5-pole or 1x connection 3x400 V, CEE 63A, 400V, 5-pole

All necessary processing equipment, activation devices and temperature measuring devices can be purchased from re-fer. A re-fer application engineer is available for construction site assignments for a fee.

Tested Sika products

Mortars

- Sika MonoTop®-452 N, shrinkage-compensated, class R4 repair mortar for horizontal surfaces
- Sika MonoTop®-422 PCC, shrinkage-compensated, class R4 repair mortar for horizontal and vertical applications
- Sika MonoTop® -412 N/DE, Eco, -4012, shrinkage-compensated, class R4 wet sprayed mortar for overhead and vertical applications
- SikaGrout®-314 N, shrinkage-free, class R4 precision grouting mortar in formwork or cut groove
- Sika® Rock Gunit BE-8 dry sprayed mortar (cementitious, alkali free)

Others

- Sika® AnchorFix® -3030, epoxy adhesive for anchorage, «cartridge»
- SikaTop® Armatec®-110 EpoCem®, bonding agent and slight corrosion coating
- Sika® FastFix-121 cement mortar for sealing surface cracks
- Sika® InjectoCem-190, very fine cement-based crack injection mortar

memory®-steel has been tested in systems with these Sika products. re-fer gives no guarantee if other mortars and products are used in combination with memory®-steel.

Approvals and test reports

- Empa, 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

Notes

All technical values in this product data sheet are subject to the re-fer 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, re-fer provides engineering support and advice. For further information please visit us at www.re-fer.eu (references, technical data sheets, brochure, tender texts, test reports and publications can be downloaded or are available upon request) or contact our technical service directly.

The information in this product data sheet is valid for the corresponding product delivered by re-fer AG Switzerland. 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.

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