

GARBA 177 SUPREME

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Precipitation hardenable stainless spring wire. Shaved and EC-tested*. For applications demanding superior fatigue properties

GARBA 177 Supreme® is a semi-austenitic precipitation-hardenable stain-less steel, processed by ESR (Electro Slag Refining), which reduces the risk of harmful inclusions. The ESR process together with a shaved surface improves the fatigue resistance as compared to GARBA 177PH.

CHEMICAL COMPOSITION

| C (%) | Si (%) | Mn (%) | P max. (%) | S max. (%) | Cr (%) | Ni (%) | Al (%) |
|-------|--------|--------|------------|------------|---------------|-------------|-------------|
| 0.09 | 0.70 | 1.00 | 0.040 | 0.015 | 16.00 - 18.00 | 6.50 - 7.80 | 0.70 - 1.50 |

CLEANLINESS IN STEEL

The presence of non-metallic inclusions in the wire rod is inspected for every heat in accordance with the Suzuki Garphyttan method by the steel supplier.

For wire rod samples: Inclusion size max. 15 µm down to 1 mm below surface. Inspection area: 350 mm².

| Inclusion size, surface | 5-10 | > 10-15 | >15 µm |
|---------------------------|--------------------------------|---------|--------|
| Max. number of inclusions | Max grade D3 acc. to JK scale* | 20 | 0 |

* Method for assessment of the content of non-metallic inclusions. Swedish Standard SS 111116 - Microscopic methods - Jernkontoret's inclusion chart II for the assessment of non-metallic inclusions.

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MECHANICAL PROPERTIES

FOR ROUND WIRE

| Diameter (mm) | Tolerance (mm) | Tensile Strength (N/mm ²) | Tensile strength after heat treatment 480C 1h (N/mm ²) |
|---------------|----------------|---------------------------------------|--|
| 0.30 - 0.40 | ±0.005 | 1885 - 2165 | 2205 - 2525 |
| 0.41 - 0.50 | ±0.008 | 1860 - 2130 | 2180 - 2490 |
| 0.51 - 0.65 | ±0.008 | 1810 - 2070 | 2130 - 2430 |
| 0.66 - 0.80 | ±0.010 | 1810 - 2060 | 2130 - 2430 |
| 0.81 - 1.00 | ±0.010 | 1780 - 2030 | 2100 - 2390 |
| 1.01 - 1.25 | ±0.015 | 1720 - 1960 | 2040 - 2310 |
| 1.26 - 1.50 | ±0.015 | 1670 - 1910 | 1990 - 2260 |
| 1.51 - 1.75 | ±0.015 | 1610 - 1850 | 1910 - 2180 |
| 1.76 - 2.00 | ±0.015 | 1570 - 1800 | 1900 - 2160 |
| 2.01 - 2.50 | ±0.015 | 1540 - 1770 | 1860 - 2120 |
| 2.51 - 3.00 | ±0.020 | 1500 - 1710 | 1820 - 2060 |
| 3.01 - 3.50 | ±0.020 | 1400 - 1600 | 1660 - 1940 |
| 3.51 - 4.25 | ±0.020 | 1350 - 1550 | 1620 - 1920 |
| 4.26 - 5.00 | ±0.025 | 1310 - 1500 | 1580 - 1800 |
| 5.01 - 5.60 | ±0.025 | 1300 - 1490 | 1550 - 1790 |

SURFACE CONDITIONS

Surface performance

AC-surface 0.30-5.60 mm Ø . The AC-coating can be removed before heat treatment by using a 10-20% nitric acid pickle at room temperature.

SURFACE CONDITION

Surface condition – non-destructive testing

In the standard size range 2.00-5,60 mm the wire can be tested continuously in Eddy Current equipment to a surface level of >40 microns.

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PHYSICAL PROPERTIES

E AND G MODULUS OF ELASTICITY

Abt. 190 kN/mm² in drawn condition.
Abt. 200 kN/mm² after heat treatment.

E AND G MODULUS OF SHEAR

Abt. 73 kN/mm² in drawn condition.
Abt. 78 kN/mm² after heat treatment.
Density: 7.90 kg/dm³.

HEAT CONDUCTIVITY

| Temperature °C | 20 | 100 | 300 |
|----------------|------|------|------|
| W/(m*°C) | 15.0 | 15.5 | 19.0 |

RESISTIVITY

| Temperature °C | 20 | 100 | 200 | 300 |
|----------------|-----|-----|------|------|
| nΩm | 900 | 950 | 1000 | 1050 |

LINEAR EXPANSION

| Pro °C | 30-100 | 30-200 | 30-300 |
|-------------------|--------|--------|--------|
| x10 ⁻⁶ | 13.0 | 13.5 | 14.0 |

SPECIFIC HEAT CAPACITY

| Temperature °C | 100 | 200 |
|----------------|-----|-----|
| J/(kg*°C) | 480 | 520 |

STANDARDS

NEAREST EQUIVALENT STEEL GRADES

EN/DIN 1.4568, AISI/SAE 631, JIS SUS 631

NEAREST EQUIVALENT STANDARDS

EN 10270-3, ASTM A313, AMS 5678, BS 2056 301 S81, JIS G4314

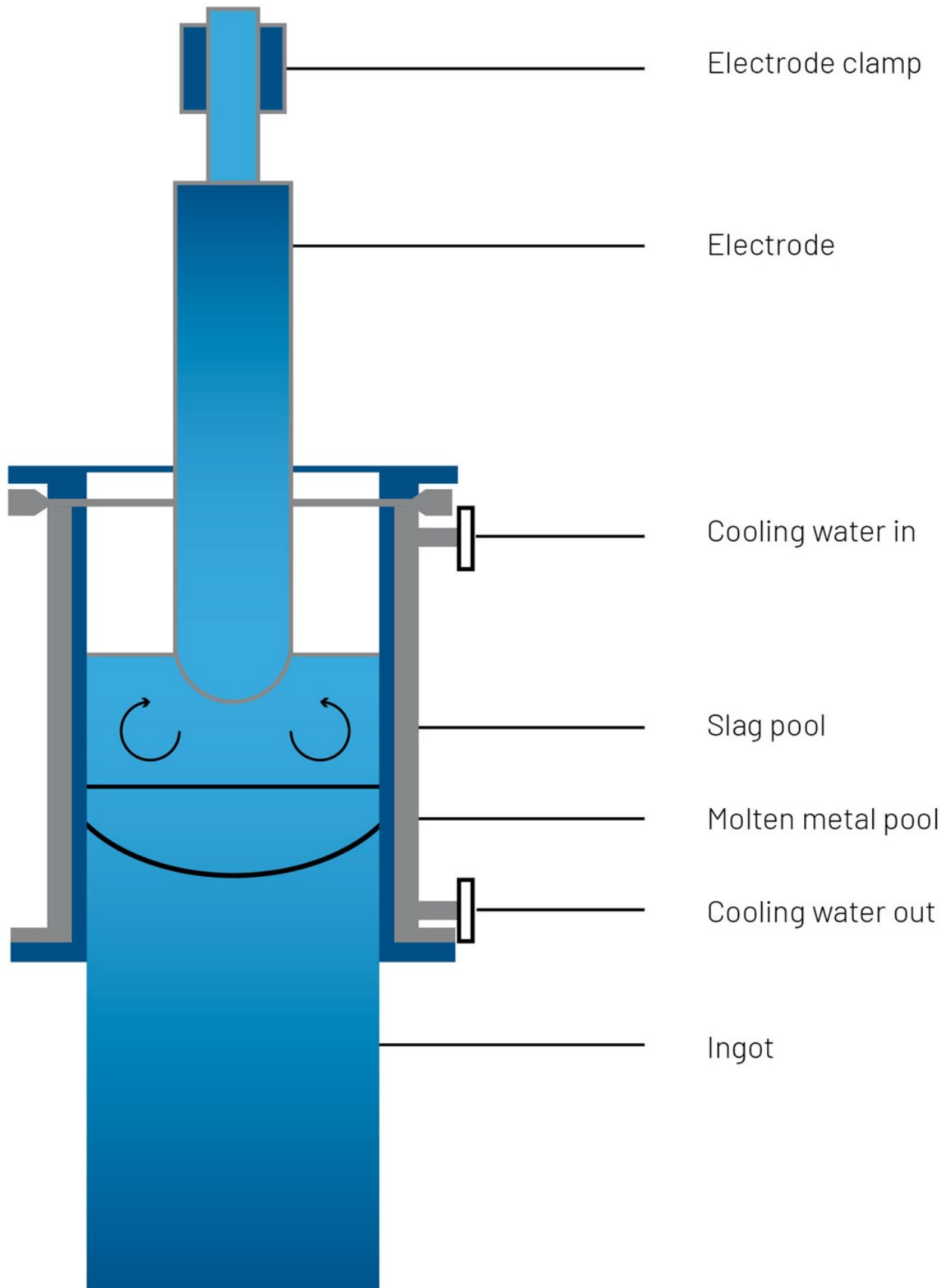
RECOMMENDATIONS

Electro slag refining (ESR) process

For further technical support, please contact Suzuki Garphyttan or visit www.suzuki-garphyttan.com for more information

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For applications demanding superior fatigue properties



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Starting plate

Water cooling

Electro Slag Refining (ESR) process

ESR process, see figure 1.

The ESR process gives a material with lower level of inclusions compared to a material not processed with ESR and in addition also a better segregation level.

Material properties achieved by ESR in combination with shaved wire surface and precipitation hardening result in superior fatigue resistance.

Shaved and Eddy Current tested

Suzuki Garphyttan uses the most advanced Eddy Current testing equipment available on the market. Experience from many years of surface testing in efficient continuous testing lines is a guarantee for high quality spring wire.

Eddy Current testing is carried out on material with high demands on surface quality. EC-testing is performed with both rotating (R) and stationary (D) probe test equipment.

| Steel grade | Dimension, mm | ESR | Shaved | Unshaved | RD40 |
|--------------------|---------------|-----|--------|----------|------|
| GARBA 177 Supreme® | 0.30 - 1.99 | x | x | - | - |
| GARBA 177 Supreme® | 2.00 - 5.60 | x | x | - | x |

Steel grade Dimension, mm ESR Shaved Unshaved RD40

GARBA 177 Supreme® 0.30 - 1.99 X X - -

GARBA 177 Supreme® 2.00 - 5.60 X X - X

HEAT TREATMENT

Normal procedure for precipitation hardening is heat treatment at 480oC (896oF) for 1 hour and then air cooling. This should be done as soon as possible after spring coiling. The tensile strength of the wire before and after this treatment is given in the table in previous page.

SHOT PEENING

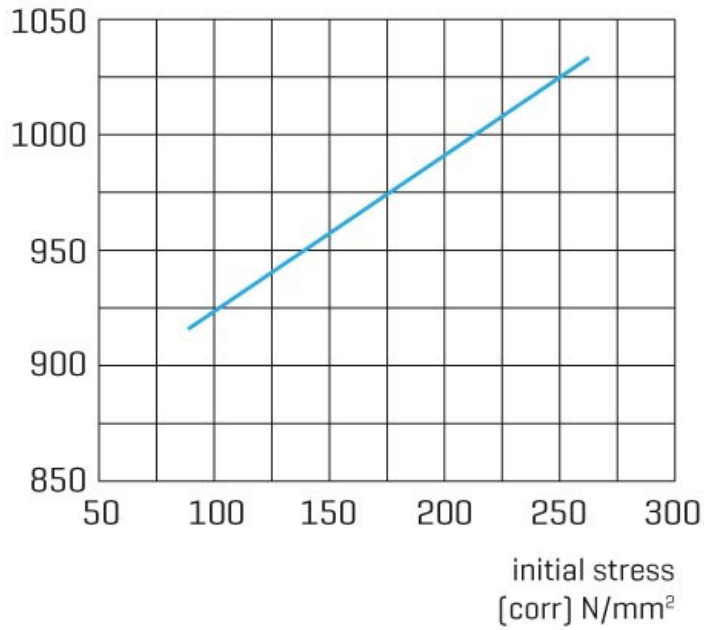
In order to obtain optimum fatigue properties, the process time should be adjusted to get a complete treatment. Size of shots should be adapted to wire dimension, pitch and shot peening equipment.

Shot peening of the inside of the spring coils is particularly critical.

RELAXATION AND FATIGUE PROPERTIES

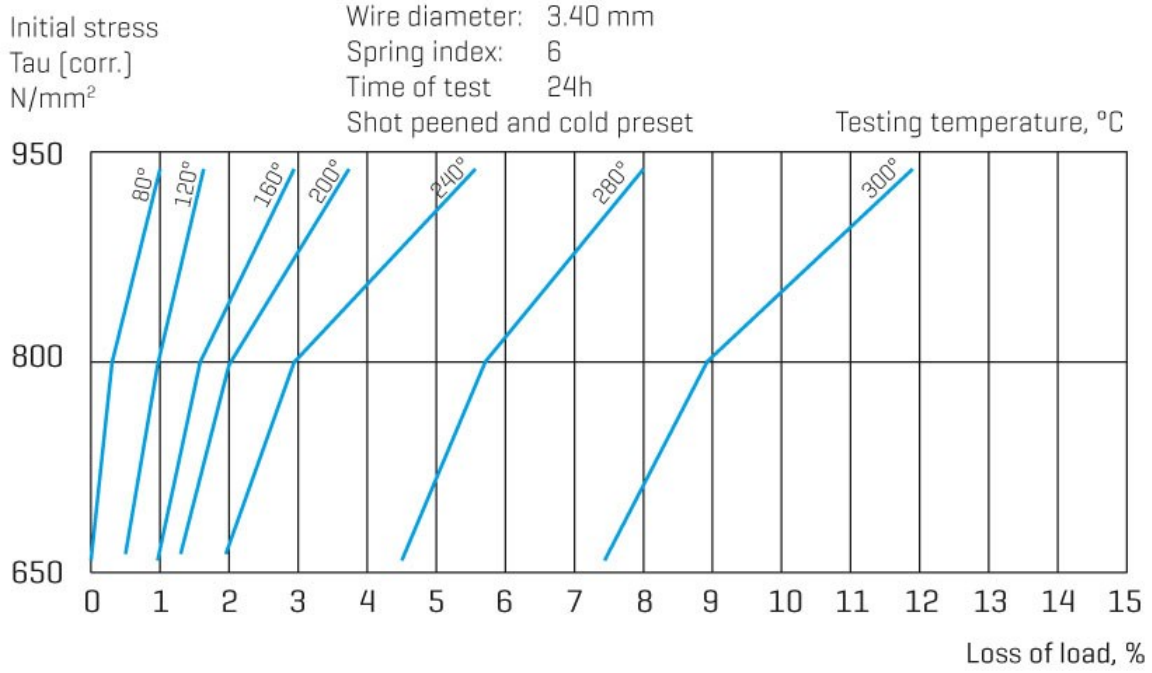
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Wire diameter: 3.40 mm
 Spring index: 6
 Number of cycles: 25×10^6
 Shot peened and hot preset
 Final stress [corr] N/mm²



In diagram 1 the fatigue properties of GARBA 177 Supreme[®] is illustrated in a Goodman-diagram, based on a special test spring design.

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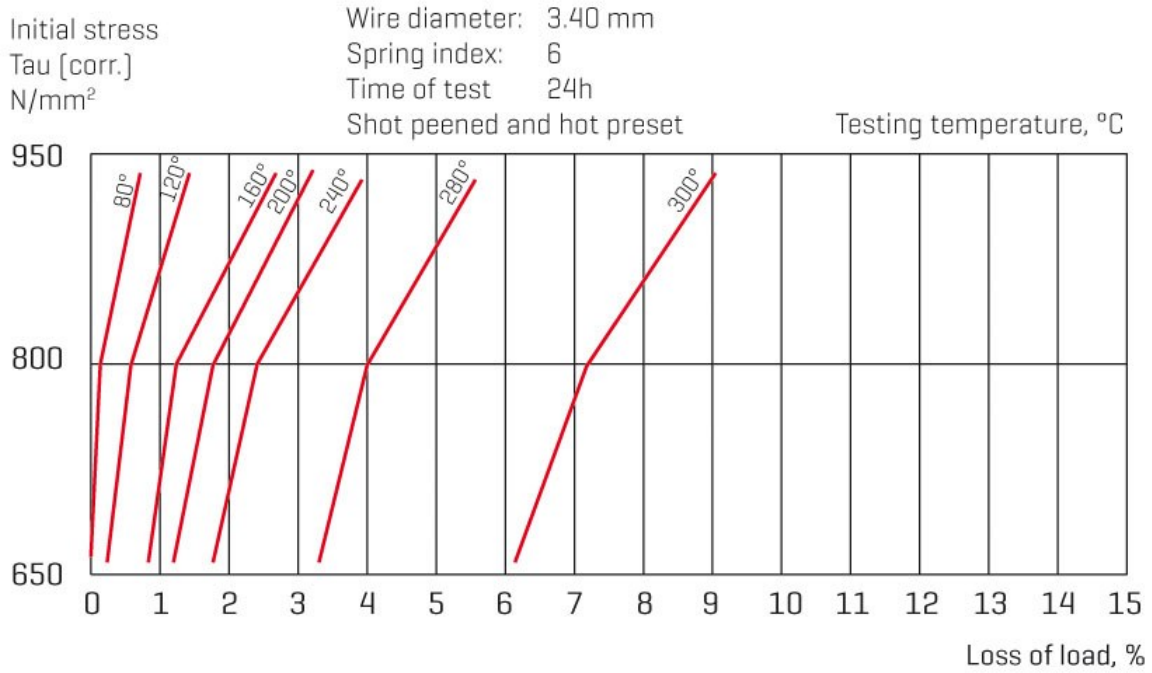


Diagram 2-3 show the relaxation properties (loss of load) of springs made from GARBA 177 Supreme[®] subjected to three different stress levels at different temperatures.