



BRODER METALS GROUP **BMG-AT41®**

Steel for power plant high temperature bolt applications

BMG-AT41® bar is ideal for high room and elevated temperature fasteners, has good creep, notch and relaxation resistance up to 570°C, and is comparable to low alloy steel turbine casting materials in terms of its thermal expansion coefficients.

These properties make the material ideal for use for turbine and process plant fasteners and for boiler support rods and is increasingly being considered for all power generation plant. Traditionally it has been used in coal fired power stations, although we have also seen demand from biomass projects and nuclear applications around the world.

The material meets or exceeds the following industry standard specifications:

- CEGB Standard 02596 - GDCD Standard 2 Issue 2 04/81 (T41)
- BS 1506 1990 681-820
- BS 1506 681-820
- BS 4882 Section 1 1990 B16A
- Siemens AG TLV 9185 01 08/02
- BSEN 10269 1999 Material Number 1.7729

Also equivalent to Durehete 1055™

The material is suitable for use in fastener specifications requiring steels and nickel alloys for fasteners with specified elevated and/or low temperature properties.

BMG-AT41® has been used directly, or approved for use by:

- Drax Power
- Siemens UK and Germany
- Doosan Babcock / Doosan Heavy Industry
- EDF (for use in Coal and Nuclear applications)
- GE (USA and UK)
- Weir Group (Allen Steam Turbines)
- Alstom (South Africa).

Chemistry Analysis (% by mass)

| | Fe | C | Si | Mn | P | S | Al | B | Cr | Mo | Ni | V | Ti | As | Sn | Cu | Sb | R* |
|-----|-----|------|------|------|------|------|-------|-------|------|------|------|------|------|------|------|------|----------|------|
| Min | Bal | 0.17 | - | 0.35 | - | - | 0.015 | 0.001 | 0.90 | 0.90 | - | 0.60 | 0.07 | - | - | - | - | - |
| Max | - | 0.23 | 0.40 | 0.75 | 0.02 | 0.08 | 0.08 | 0.01 | 1.20 | 1.10 | 0.20 | 0.80 | 0.15 | 0.02 | 0.02 | 0.20 | Reported | 0.10 |

*R=P+2.43As+3.57Sn+8.16Sb+0.13Cu

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Testing & Reporting Regime

- 100% of bars are hardness tested, and the hardest & softest bars are selected for full mechanical testing and must meet the testing property requirements (see below) in the longitudinal direction.
- 100% of bars are spectroscopy analysed and results compared against the relevant standard.
- 100% of bars are Circograph tested and Ultrasonically tested to DIN EN 10308.03/02 Class 4.

All material is delivered fully identified and batch traceable, along with mill or Broder Metals Group EN 10204 3.1 certification at customer's request. All certification shows manufacturing process number, chemical analysis, mechanical properties results from tests from the hardest and softest bars, both Charpy & IZOD impact test results, non-destructive testing results, heat treatment times and temperature, mill and independently tested grain size and microstructural examination details.

Additional testing can be carried out to satisfy critical requirements at independent test houses as required.

Heat Treatment

| | | | |
|-------------|---------------------|--------------|-----------|
| | Sub Critical Anneal | Harden | Temper |
| - | 600-700° C | 970-990° C | 680-720°C |
| All sizes | Air Cool | - | Air Cool |
| <35mm dia | - | Oil | - |
| 35-50mm dia | - | Oil or Water | - |
| >50mm dia | - | Water | - |

Complies with requirements of BSEN 10269:1999: 20CrMoVTiB4-10

Mechanical Properties (Room Temperature)

| Dia | 0.2% PS n/mm ² | UTS n/mm ² | Elongation % on 5d min | Red of Area % min | Energy Impact | |
|-----------|------------------------------|--------------------------|------------------------------|-------------------------|-----------------|---------------|
| | | | | | Charpy J ave | IZOD J min |
| <= 100 mm | 660 | 820-970 | 15 | 50 | 40 | 27 |
| >100 mm | 660 | 820-970 | 15 | 50 | 27 | 27 |

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Production

The material is produced via the ingot cast route (ingot cast material tends to produce a finer grain structure than continuous cast (concast) material and was specified in initial proving trials).

The material is heat treated in accordance with BSEN 10269:1999; 20CrMoVTiB4-10 with appropriate sub-critical annealing, hardening and tempering cycles according to the diameter of the material. Every bar is subject to spectroscopy analysis, and every bar is Circograph and Ultrasonically tested to DIN EN 10308 03/12 CLASS 4.

Independent microstructural examination from one longitudinal section across the full cross-sectional width of the bar product is carried out and reported as standard for each cast of material (see testing section later).

Grain size testing to ASTM E112 with acceptance limits of size 5 or finer is also reported as standard for each cast.

The following additional information is supplied as standard on all Mill and Broder Metals Group's own EN 10204 3.1 certificates (either/both supplied at the request of the customer):

- Values of Sb (Antimony) and R – normally the Sb value is not reported unless specifically requested, but without which the value of R cannot be independently checked.
- The results of the independent microstructural examination on each cast.

It is Broder Metals Group's intention to maintain a full range of sizes and offer our trademark service level of same/next day despatch as with as every other material in our product range.

Other properties in accordance with BS EN 10269:1999.

UTS allowable maximum is 1000 n/mm²

Charpy impact is average of 3 specimens

IZOD impact is minimum value required

Test piece position - generally in accordance with BSEN 10269:1999

Unless otherwise stated, all data is in accordance with BS EN 10269:1999: 20CrMoVTiB4-10, Material number 1.7729

Mechanical Properties (Elevated Temperature)

| Diameter <= 160mm | | | | | | | | | | | |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Temperature | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 600 |
| 0.2% Proof Stress (n/mm ²) minimum | 642 | 624 | 603 | 595 | 581 | 573 | 559 | 537 | 508 | 464 | 406 |

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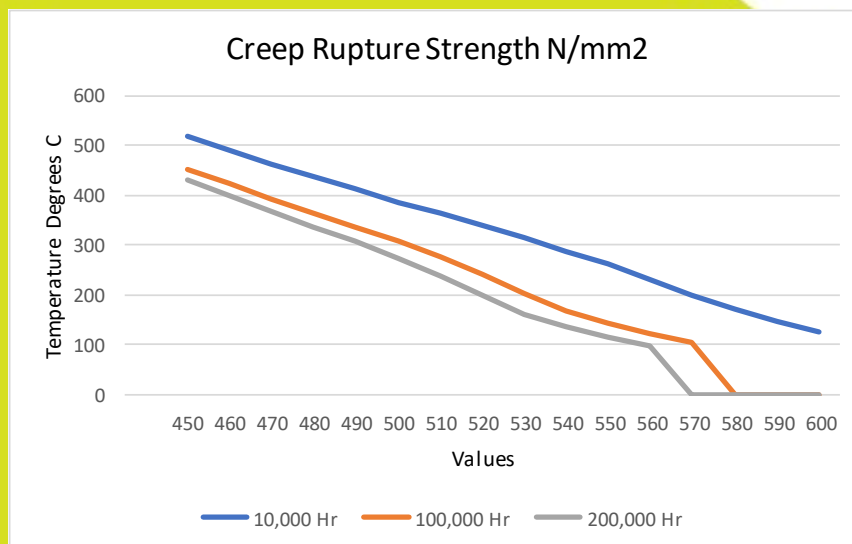
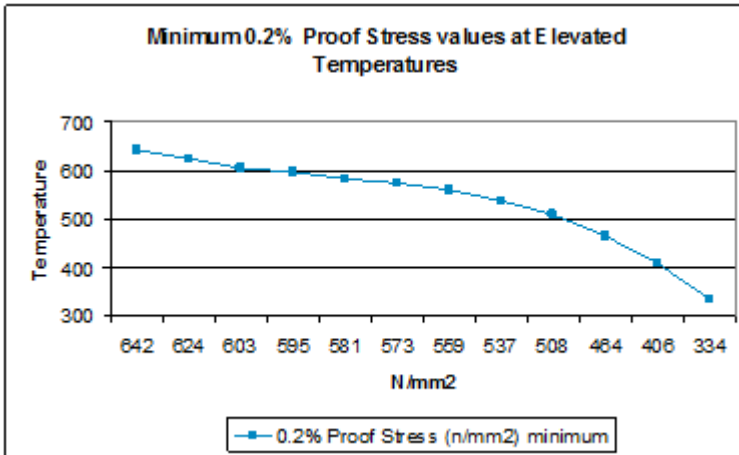


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| Temperature (° C) | Residual Stress n/mm ² | | |
|-------------------|-----------------------------------|----------|----------|
| | 1.00hr | 10.000hr | 30.000hr |
| 400 | 247 | 224 | 212 |
| 450 | 216 | 188 | 173 |
| 500 | 180 | 141 | 118 |
| 550 | 134 | 70 | 42 |
| 600 | 61 | - | - |

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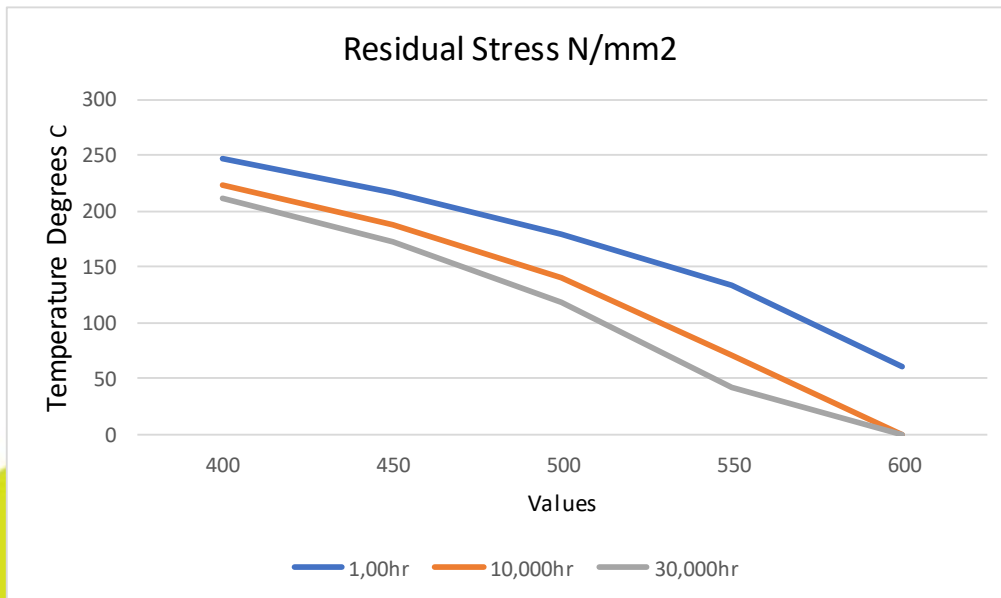


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Creep Rupture Strength

| Temperature (Degrees C) | Creep Rupture Strength n/mm ² | | |
|-------------------------|--|------------|------------|
| | 10,000 Hr | 100,000 Hr | 200,000 Hr |
| 450 | 520 | 453 | 430 |
| 460 | 491 | 423 | 399 |
| 470 | 463 | 394 | 369 |
| 480 | 437 | 365 | 338 |
| 490 | 412 | 337 | 307 |
| 500 | 384 | 307 | 274 |
| 510 | 364 | 276 | 237 |
| 520 | 340 | 241 | 198 |
| 530 | 315 | 204 | 162 |
| 540 | 288 | 169 | 135 |
| 550 | 261 | 142 | 114 |
| 560 | 231 | 121 | 96 |
| 570 | 200 | 103 | - |
| 580 | 170 | - | - |
| 590 | 146 | - | - |
| 600 | 127 | - | - |

This alloy is just one of a range of bolting materials stocked by Broder Metals Group Ltd – please see our website for the full range stocked: www.broder-metals-group.com

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