

# Manaurite<sup>®</sup> XMM



**MANOIR**  
A PARALLOY GROUP COMPANY

## CHEMICAL COMPOSITION

| Element   | Minimum | Maximum |
|-----------|---------|---------|
| C         | 0.45    | 0.50    |
| Mn        | -       | 1.50    |
| Si        | 1.20    | 2.0     |
| Ni        | 32.0    | 36.0    |
| Cr        | 24.0    | 27.0    |
| Nb        | 0.50    | 1.0     |
| Ti, Zr, W | Add     | Add     |

(Typical composition, slight modifications can be carried out depending on the application).

## PHYSICAL PROPERTIES

Specific gravity: 8.02 kg/dm<sup>3</sup> (0.29 lb/inch<sup>3</sup>)  
Melting point: 1 350°C (2 460°F)

### Coefficient of expansion

| Temperature range                         | mm/mm°C x 10 <sup>-6</sup><br>(in/in°F x10 <sup>-6</sup> ) |
|-------------------------------------------|------------------------------------------------------------|
| From 20°C to 850°C<br>(70°F to 1 560°F)   | 18.5<br>(10.21)                                            |
| From 20°C to 950°C<br>(70°F to 1 740°F)   | 18.9<br>(10.4)                                             |
| From 20°C to 1 050°C<br>(70°F to 1 920°F) | 19.3<br>(10.6)                                             |
| From 20°C to 1 150°C<br>(70°F to 2 100°F) | 19.7<br>(10.9)                                             |

### Thermal conductivity

At 1 050°C (1 922°F): 30 W/m.°C (17.34 BTU/h.ft.°F)  
At 20°C (77°F): 10.5 W/m.°C (6.07 BTU/h.ft.°F)

## Specific heat

| °C    | °F    | Cal/g.°C<br>Or<br>BTU/lb.°F | J/kg.°C |
|-------|-------|-----------------------------|---------|
| 20    | 68    | 0.112                       | 469     |
| 100   | 212   | 0.117                       | 489.9   |
| 200   | 392   | 0.124                       | 519.3   |
| 300   | 572   | 0.130                       | 544.4   |
| 400   | 752   | 0.137                       | 573.7   |
| 500   | 932   | 0.143                       | 598.8   |
| 600   | 1 112 | 0.150                       | 628.2   |
| 700   | 1 292 | 0.157                       | 657.5   |
| 800   | 1 472 | 0.163                       | 682.6   |
| 900   | 1 652 | 0.170                       | 711.9   |
| 1 000 | 1 832 | 0.177                       | 741.2   |
| 1 100 | 2 012 | 0.183                       | 766.4   |
| 1 200 | 2 192 | 0.190                       | 795.7   |

## Modulus of elasticity

| °C    | °F    | MPa     | ksi    |
|-------|-------|---------|--------|
| 20    | 68    | 161 900 | 23 470 |
| 100   | 212   | 155 000 | 22 475 |
| 200   | 392   | 147 150 | 21 337 |
| 300   | 572   | 138 000 | 20 010 |
| 400   | 752   | 133 400 | 19 343 |
| 500   | 932   | 126 000 | 18 270 |
| 600   | 1 112 | 117 700 | 17 066 |
| 700   | 1 292 | 111 000 | 16 095 |
| 800   | 1 472 | 106 000 | 15 360 |
| 900   | 1 652 | 101 000 | 14 650 |
| 1 000 | 1 832 | 97 100  | 14 080 |
| 1 100 | 2 012 | 93 200  | 13 510 |

## MECHANICAL PROPERTIES

### 1. At room temperature (minimum values)

Ultimate tensile strength: 450 MPa – 65.000 psi

Yield strength: 250 MPa – 35.500 psi

Elongation (on 4d): 8% for centrifugally cast pipes & 6% for static castings

### 2. Short time tensile tests at various temperatures on as cast material

| Temperature |       | U.T.S. |      | Y.S. |      | E  |
|-------------|-------|--------|------|------|------|----|
| °C          | °F    | MPa    | ksi  | MPa  | ksi  | %  |
| 750         | 1 380 | 333    | 48.4 | 157  | 22.8 | 16 |
| 800         | 1 470 | 265    | 38.2 | 147  | 21.3 | 20 |
| 850         | 1 560 | 196    | 28.4 | 137  | 19.9 | 22 |
| 900         | 1 650 | 147    | 21.3 | 118  | 17.1 | 30 |
| 950         | 1 740 | 118    | 17.1 | 88   | 12.8 | 32 |
| 1 000       | 1 830 | 93     | 13.5 | 78   | 11.4 | 38 |
| 1 050       | 1 920 | 74     | 10.7 | 69   | 10.0 | 47 |
| 1 100       | 2 010 | 61     | 8.8  | 55   | 8.0  | 39 |

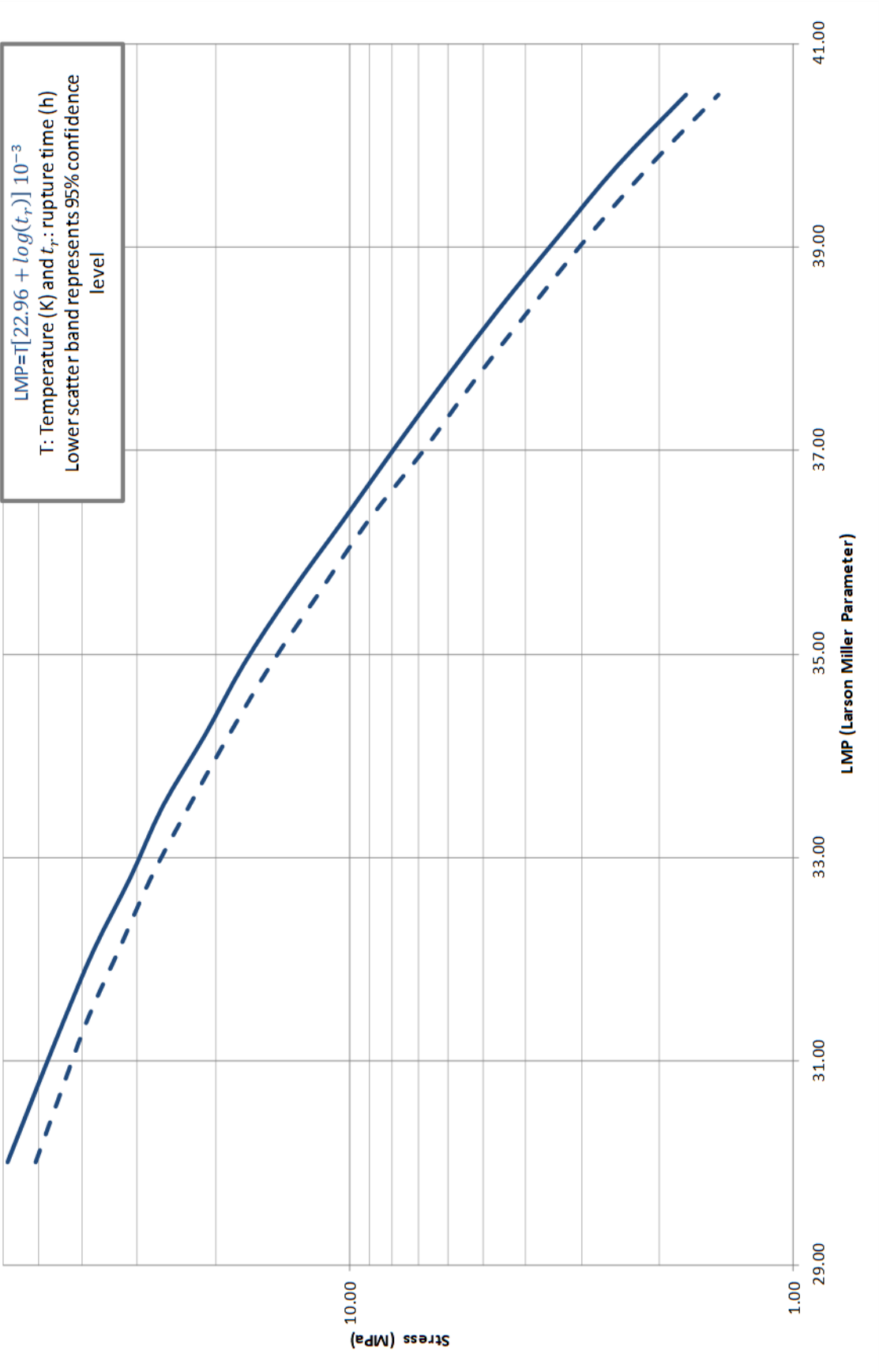
(typical values)

### 3. Long time tests: creep properties

Stress rupture properties: 100 000 hours

| Temperature |       | Average values |      | Minima values |      |
|-------------|-------|----------------|------|---------------|------|
| °C          | °F    | MPa            | ksi  | MPa           | ksi  |
| 800         | 1 470 | 59.00          | 8.55 | 51.00         | 7.39 |
| 825         | 1 515 | 51.00          | 7.39 | 44.63         | 6.47 |
| 850         | 1 560 | 44.00          | 6.38 | 39.00         | 5.65 |
| 875         | 1 605 | 37.62          | 5.45 | 33.01         | 4.78 |
| 900         | 1 652 | 31.20          | 4.52 | 28.00         | 4.06 |
| 925         | 1 697 | 26.39          | 3.82 | 23.00         | 3.33 |
| 950         | 1 742 | 21.20          | 3.07 | 18.70         | 2.71 |
| 975         | 1 787 | 17.32          | 2.51 | 15.00         | 2.17 |
| 1 000       | 1 832 | 13.59          | 1.97 | 11.70         | 1.70 |
| 1 025       | 1 877 | 10.40          | 1.51 | 9.10          | 1.32 |
| 1 050       | 1 922 | 8.00           | 1.16 | 6.80          | 0.99 |
| 1 075       | 1 967 | 6.10           | 0.88 | 5.20          | 0.75 |
| 1 100       | 2 012 | 4.60           | 0.67 | 3.90          | 0.57 |
| 1 125       | 2 057 | 3.40           | 0.50 | 2.90          | 0.42 |
| 1 150       | 2 102 | 2.50           | 0.36 | 2.10          | 0.31 |
| 1 175       | 2 147 | 1.75           | 0.25 | 1.47          | 0.21 |

CREEP RUPTURE DATA (95% CONFIDENCE LEVEL)

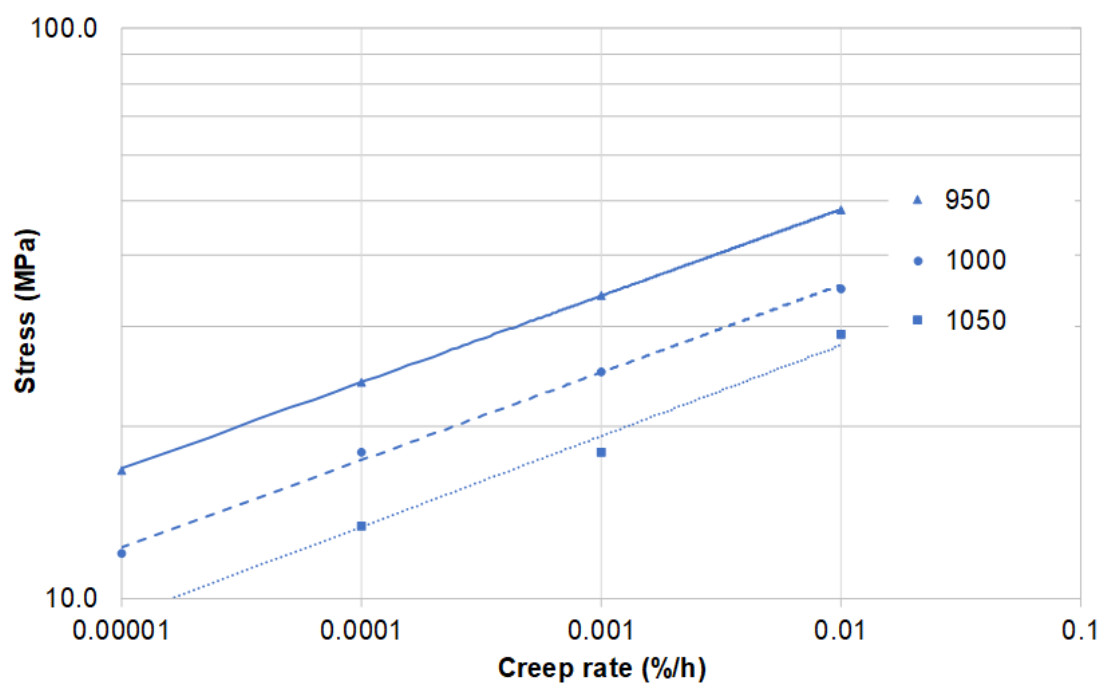


#### 4. Creep rate

Creep rates (material stabilized 1 050°C – 500 hrs)

| Creep rates<br>(% x hr <sup>-1</sup> ) | Stresses in MPa  |                    |                    |
|----------------------------------------|------------------|--------------------|--------------------|
|                                        | 950°C<br>1 757°F | 1 000°C<br>1 850°F | 1 050°C<br>1 922°F |
| 10 <sup>-2</sup>                       | 48               | 35                 | 29                 |
| 10 <sup>-3</sup>                       | 34               | 25                 | 18                 |
| 10 <sup>-4</sup>                       | 24               | 18                 | 13.4               |
| 10 <sup>-5</sup>                       | 16.8             | 12                 | 9.4                |

#### CREEP RATES MANAURITE® XM



## CARBURIZATION RESISTANCE DATA

Pack cement carburization test results

850°C – 1 150°C (1 562°F – 2 102°F) 14 Days

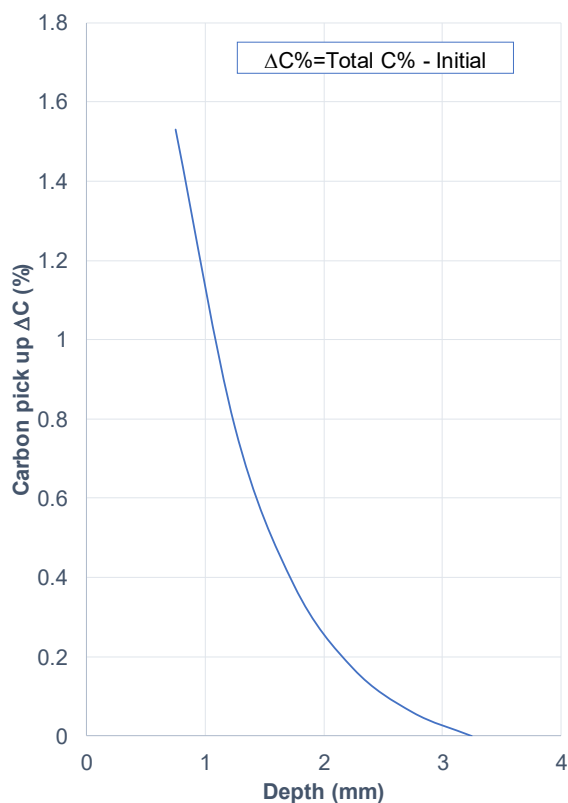
| Inside (mm) | Minima values |      |
|-------------|---------------|------|
|             | %C            | ΔC%  |
| 0.75        | 1.98          | 1.53 |
| 1.25        | 1.23          | 0.78 |
| 1.75        | 0.83          | 0.38 |
| 2.25        | 0.62          | 0.17 |
| 2.75        | 0.51          | 0.06 |
| 3.25        | 0.45          | 0.00 |
| 3.75        | 0.45          | 0.00 |
| 4.25        | 0.45          | 0.00 |
| 4.75        | 0.45          | 0.00 |

Test conditions:

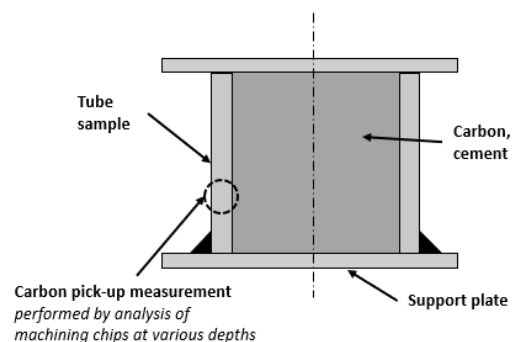
Holding for 2 days at each temperature with an increase of 50°C (122°F) every two days from the minimum temperature to the maximum temperature.

ΔC% = Enrichment in carbon = total carbon% - initial carbon%

### PACK CEMENT CARBURIZATION TEST (850°C – 1 150°C)



### CARBURIZATION TEST



---

## MANOIR FRANCE

**Future is our raw material.**

As a metal processing specialist, Manoir Industries develops alloys and operates processes for the manufacture of high-performance components. Known and recognised for several decades, its know-how is complemented by its expertise in casting, forging, boilermaking, welding and assembly. Manoir's solid technical expertise continues to drive its sustainable leading position, offering innovative services to its customers worldwide as a true partner.