

**Macalloy**

BAR & CABLE SYSTEMS

Macalloy 1030

# Foundation Anchor Solutions for Wind Turbines



**ASQPE**

**CE**

ETA-07/0046



**EXPERIENCE**

**INNOVATION**

**QUALITY**

## Introduction

With over 60 years of heritage, Macalloy are the most experienced bar threading company in the UK with a proven track record at the forefront of bar threading technology.

The "Macalloy Bar" was first introduced to the construction industry in 1948 as the worlds first post tensioning bar, developed initially for use in prestressed and post tensioned concrete construction.

The benefits of using the Macalloy bar have been widely recognised across the construction industry and it is now used extensively in many different structural applications. Amongst these are several applications suited to the wind turbine market: -

### Why use the Macalloy 1030?



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## Table 1: Mechanical Properties

Grade	Nominal ultimate tensile strength	Nominal 0.1% proof stress	Minimum elongation	Approximate modulus of elasticity
	N/mm <sup>2</sup>	N/mm <sup>2</sup>	%	kN/mm <sup>2</sup>
Macalloy 1030 25-40mm	1030	835	6	170*
Macalloy 1030 50-75mm	1030	835	6	205
Macalloy S1030 20-50mm	1030	835	10	185

\*Secant Modulus of Elasticity in range 5 - 70% UTS

- Stressed connections:
  - Concrete to concrete
  - Concrete to steel
  - Steel to steel
- Holding down bolts
- Ground and rock anchorages

### Strength

The mechanical properties of the Macalloy 1030 bars can be found in Table 1.

Bars are supplied with a range of

fittings, including nuts, washers, plates and couplers. Spherical nuts and washers are also available to accommodate up to 3 degrees of rotation. All fittings are designed to exceed the failing load of the threaded bars.

The specified characteristic failing load and 0.1% proof load for the Macalloy 1030 bar are given in Table 2.

### Rolled Threads and Fatigue

All the Macalloy 1030 bars have the unique Macalloy rolled thread rather than a cut thread, offering a distinct advantage with regard to fatigue performance.

In rolling a thread the grain structure of the material is aligned with the peaks and troughs of the thread, providing a smooth running thread form. As the threading operation is effectively a cold working operation, it results in a local increase in the tensile properties to the surface of the bar. With a cut thread the grain structure is removed creating dislocations within the material and potential areas of crack propagation. It has been proved via testing that a rolled thread, with its smooth thread form and increased strength, results in improved fatigue performance.

Macalloy threaded assemblies have a fatigue resistance in excess of two million cycles of loading over a tensile stress range of 80N/mm<sup>2</sup>. As part of the approval, regular tests are carried out on the bars. Contact Macalloy's Technical Department for further information.

### Relaxation

The requirements laid down in BS4486 for the loss of stress due to relaxation in a bar loaded to 70% of its characteristic failure load, after 1000 hours at room temperature, is 3.5% maximum. Macalloy carries out tests in its own test house along with independent audit tests, the results of which show the bars comfortably achieve results below 3.0%.

### Lock Off Losses

The 'lock off' losses exhibited with the Macalloy 1030 bar are typically 0.5mm if the load is cycled and locked off several times. This can be reduced even further if a torque is applied to the nut after the final load cycle.

### Corrosion Protection

Standard corrosion protection of the Macalloy 1030 bar when used in wind turbine foundations is by

wrapping the bar in Denso/PVC tape. This is carried out quickly and efficiently in the macalloy factory using Macalloy's unique Denso tape machine.

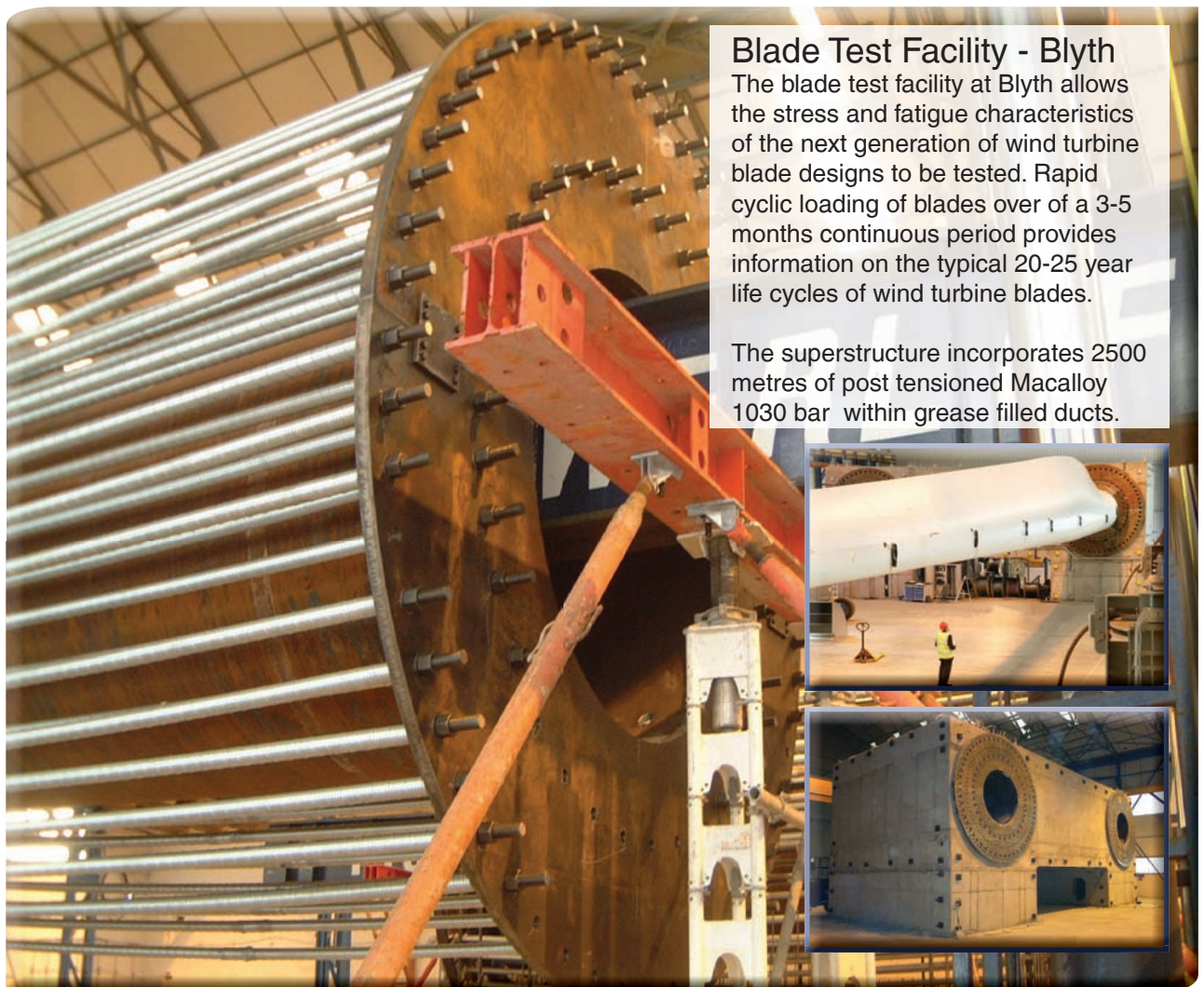
Other forms of corrosion protection can be offered. See the Macalloy 1030 brochure for further details.

As an alternative to the carbon steel bar, Macalloy also offers the Stainless Macalloy S1030 bar. This is a precipitation-hardened stainless steel with corrosion

**Table 2: Characterisitc Loads**

Nominal Bar Dia.	mm	20**	25	26.5*	32	36*	40	50	75*
0.1% Proof Load	kN	262	410	460	670	850	1050	1639	3495
Falling Load	kN	323	506	569	828	1049	1295	2022	4311
Norminal Bar Weight	(kg/m)	2.53	4.09	4.58	6.63	8.35	10.3	15.72	33.0

\*Available in Carbon steel only  
 \*\* Available in Stainless steel only



### Blade Test Facility - Blyth

The blade test facility at Blyth allows the stress and fatigue characteristics of the next generation of wind turbine blade designs to be tested. Rapid cyclic loading of blades over of a 3-5 months continuous period provides information on the typical 20-25 year life cycles of wind turbine blades.

The superstructure incorporates 2500 metres of post tensioned Macalloy 1030 bar within grease filled ducts.



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## Wind Farm Applications

### Uljabuouda - Sweden

The wind farm at Uljabuouda consists of a total of 10 3MW wind turbines, with a total annual production of 80 GWh. The turbines will supply electricity to more than 3000 homes.

Macalloy 40mm bars were installed as part of the foundation system. 136 bars at approximately 2.6 m long

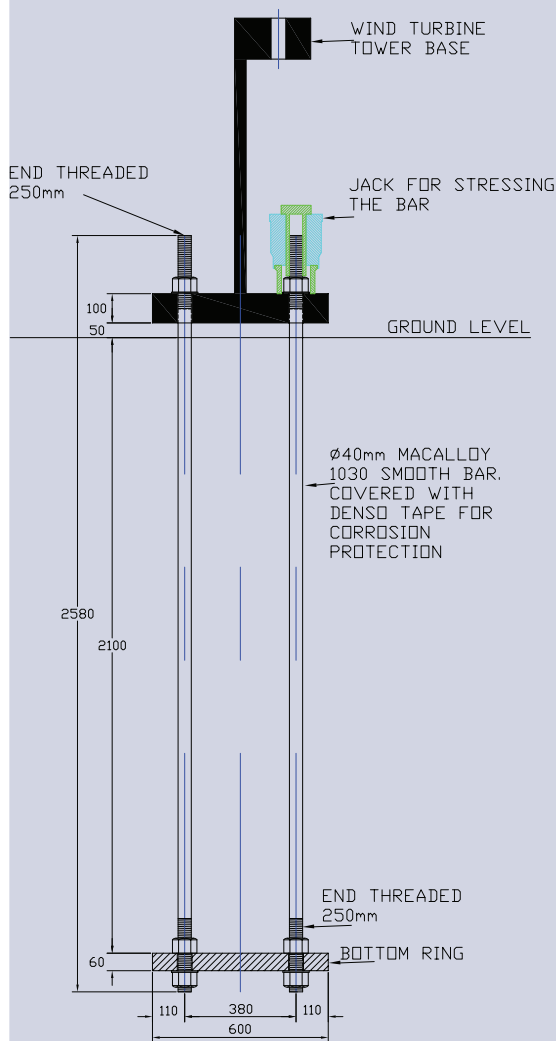
were supplied to each wind turbine, using Denso/ PVC tape for corrosion protection.

The first four wind turbines are expected to begin operations in the autumn of 2009 and the remaining six in the summer of 2010.

The bars serve a dual purpose, not

only do they provide a means of stressing the concrete foundations but also they act as the holding down bolts for the base of the wind turbine tower.

### Uljabuouda - Sweden



FOUNDATION BAR ARRANGEMENT FOR THE ULJABUQUODA WIND FARM PROJECT



This publication provides the technical details currently used by Macalloy in the manufacture of its components.

The company reserves the right to amend technical details as and where necessary in line with its policy of continuous development.

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