Marine Shafting Alloys

TD01

INTRODUCTION TO MARINE SHAFTING ALLOYS.

Over the past few years there has been a significant change in shafting materials, away from the traditional 316 stainless steels, towards more advanced 'duplex' metallurgically structured, high performance stainless steel alloys.

This range of duplex alloys offers the designer substantially increased physical properties, particularly strength, and markedly improved resistance to crevice corrosion and corrosion fatigue.

Whilst 316 series stainless steels are excellent materials for general use, duplex alloys are now preferred. These alloys offer much higher strength and are more cost effective than other high performance stainless steels and more exotic materials. Consequently, duplex stainless alloy shafts can safely be designed with substantially reduced diameters compared to those made of the 316 series, giving the architect and boat constructor much greater freedom than previously, and often providing significant weight saving advantages.

F51 DUPLEX

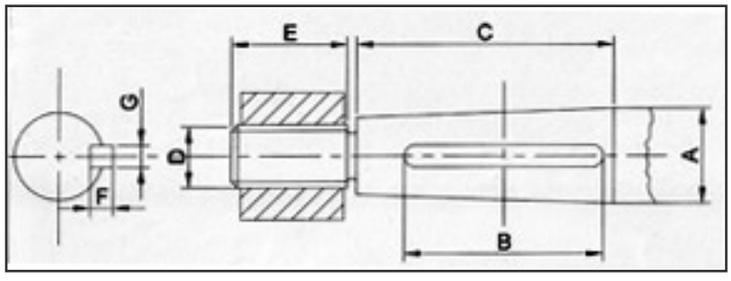
This high performance second generation Duplex stainless alloy is recommended as having one of the finest combinations of properties for propeller shafting and is highly competitive in price. The alloy has excellent corrosion fatigue resistance properties, and combined with high strength and ductility, enables the use of comparatively smaller shaft diameters. The consequent reduction in weight, and size of associated gear offers improved boat performance and economy of installation and boat operation.

MARINE APPLICATIONS

F51 DUPLEX boat shafting is particularly useful in high performance applications where high acceleration and heavy duty operation is expected.

Clements Marine can also supply special purpose stainless alloys for specific applications on request.

SHAFTING DESIGN ENQUIRIES
Technical Data sheet TD12 should be used for calculation and submission of designs to Clements Marine, enabling us to consider your requirements allowing for such issues as shaft diameters, propeller loading and bearing spacing. The schematic below can be referred to when calling our office.



F51 DUPLEX ALLOY MECHANICAL AND CHEMICAL PROPERTIES
Information is based on data provided by the alloy manufacturing mill, tests carried out at independent test houses under the supervision of Lloyds Register of Shipping and from the relevant international standards.

F51 DUPLEX
UTS 680-880, 0.2% Proof 450(N/sqmm), %Elongn 25, HB 200-277. Chemical analysis includes, 2.5-3.0% Mo,4.5-6.0% Ni, 21-23% Cr, 2.0%max Mn.

METALLURGICAL FEATURES

F51 DUPLEX (High Performance Duplex) boat shafting material is a Duplex stainless steel in which two crystallographic phases, ferrite and austenite, are present. By this means enhanced and desirable features, e.g. strength, toughness and corrosion resistance, can be present within a single alloy.

To attain this, the austenite and ferrite forming elements of the chemical analysis are controlled to ensure a stable microstructure comprising of between 35% to 50% austenite in a ferritic matrix.

This metallurgical structure gives the following benefits:-

-High strength compared to standard fully austenitic material.
-Relatively high toughness resulting from the combination of strong austenite with ductile ferrite.
-Resistance to stress corrosion cracking (SCC) is significantly raised by the ferrite.
-Corrosion pitting resistance and ductility, due to the Nitrogen, a potent austenite stabiliser.
-Improved resistance to abrasion and erosion at high flow rates.

CORROSION RESISTANCE

CORROSION ISSUES. Technical Data sheet TD15 can be consulted regarding issues of marine corrosion generally, and specifically in relation to the shafting alloys.

Stress Corrosion Cracking (SCC)
In chloride bearing solutions ferritic-austenitic steels (Duplex) are markedly more resistant to SCC than low alloy austenitic (316) or martensitic precipitation-hardening stainless steels (17 4PH).

Shaft failure due to SCC is caused in the stainless steels when complex oxide corrosion products at the molecular level lead to a weakening of the material, especially under cyclically stressed conditions.

Comparative laboratory test illustrate this point. Figures given are the applied stresses, expressed as a percentage of UTS, required to induce failure after 500 hours in 40% calcium chloride solution at 100 deg Centigrade (accelerated test conditions).

F51 DUPLEX (Duplex) - 90%
17 4PH (Martensitic PH) - 10%
316 Stainless(Austenitic) - 30%

Corrosion Fatigue.
The high mechanical strength and superior corrosion resistance of F51 DUPLEX ensures excellent fatigue strength under corrosive conditions. Rotary bending tests in artificial seawater at 40 deg C gives stress levels of 430 N/sq mm to bring about rupture of smooth samples after 20 million cycles at 600 RPM.

Intergranular Corrosion.
The carbon content of F51 DUPLEX is kept below 0.03% to avoid intergranular corrosion.