JANUARY 2002

SPRING DESIGN DATA SHEET **7**

DESIGN STRESSES FOR SPRINGS

THE INSTITUTE OF SPRING TECHNOLOGY LTD

CONTENTS

DESIGN STRESSES FOR SPRINGS

Introduction

There are three classifications of severity of stressing and the decision as to which one is involved will determine for any material the maximum permissible operating stress selected. They are:

(i) static loading, i.e. where loading and unloading of the spring occurs comparatively rarely, i.e. not more than (say) 10 000 times during its life.

(ii) limited life fatigue loading: i.e. where loading and unloading of the spring occurs a large but limited number of times, say 10^4 to 10^6 cycles, during its life.

(iii) unlimited life fatigue loading, i.e. where the loading and unloading of the spring occurs a very large or unlimited number of times, say more than 10^6 cycles, during its life.

For a given material a statically loaded spring can safely carry a higher stress than one operating under fatigue conditions, whether the latter be of limited or unlimited life. A limited life spring will be able to carry safely a higher fatigue stress than one required to operate for unlimited life.

The maximum permissible fatigue stress in a spring is dependent on the stress range, i.e. the difference between the maximum and minimum stresses. For example, a spring, which will operate satisfactorily over the stress range 200 – 1000 N/mm^2 will not give such reliable service over the range 0 – 1000 N/mm^2. In the latter case the maximum stress would have to be lowered by an amount dependent on the materials and the surface condition (to perhaps 800 N/mm^2 or less).

The stresses given in this data sheet are for materials which have received the optimum low temperature heat treatment to give the maximum torsional elastic limit and have been subsequently prestressed in manufacture. They are also corrected for coil curvature. They should not therefore be confused with the lower maximum values which the material would withstand in the condition in which it is delivered to the spring maker. The values relate to springs which will be used at room temperature and in an environment which is non-corrosive for that particular material.

The Goodman type fatigue diagrams relate to springs required to withstand cyclical stressing up to 10^7 cycles.

If loads are applied at high velocity the maximum fibre stress will be much higher than in the case of slow cyclical loading of the same amplitude. In such cases it will be necessary for the designer to determine the maximum fibre stress that the operating conditions will impose on the spring in order to ensure a satisfactory spring performance.

The recommended maximum permissible stresses are those that the fibres of the material will withstand irrespective of the type of loading, i.e. whether due to slow cyclical loading, rapid cyclical loading giving rise to surging, impulsive (impact) loading, or wave forms which are not simple harmonic.

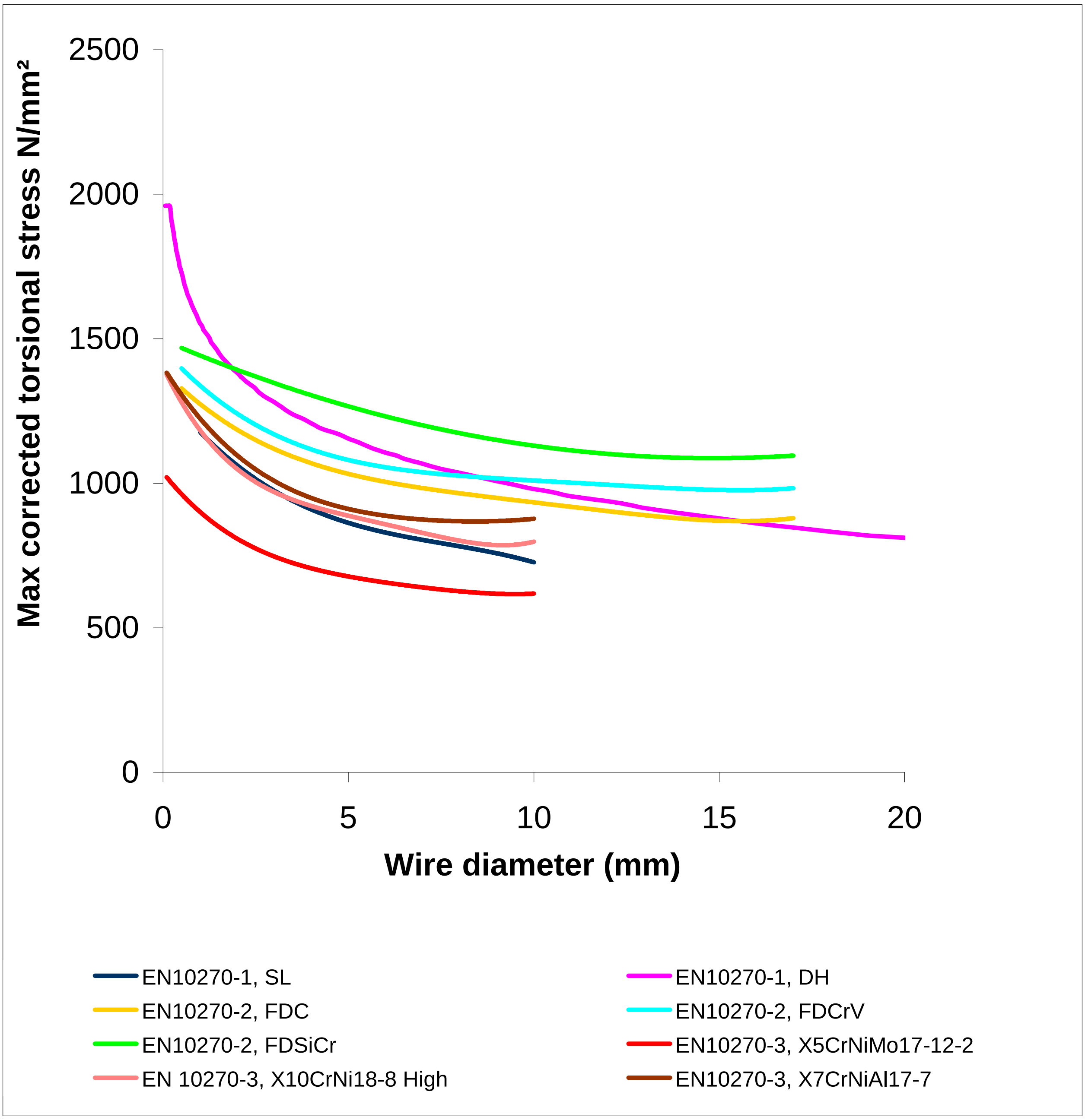

Figure 1 Relative maximum permissible static operating stresses for spring materials which have been low temperature heat treated and prestressed

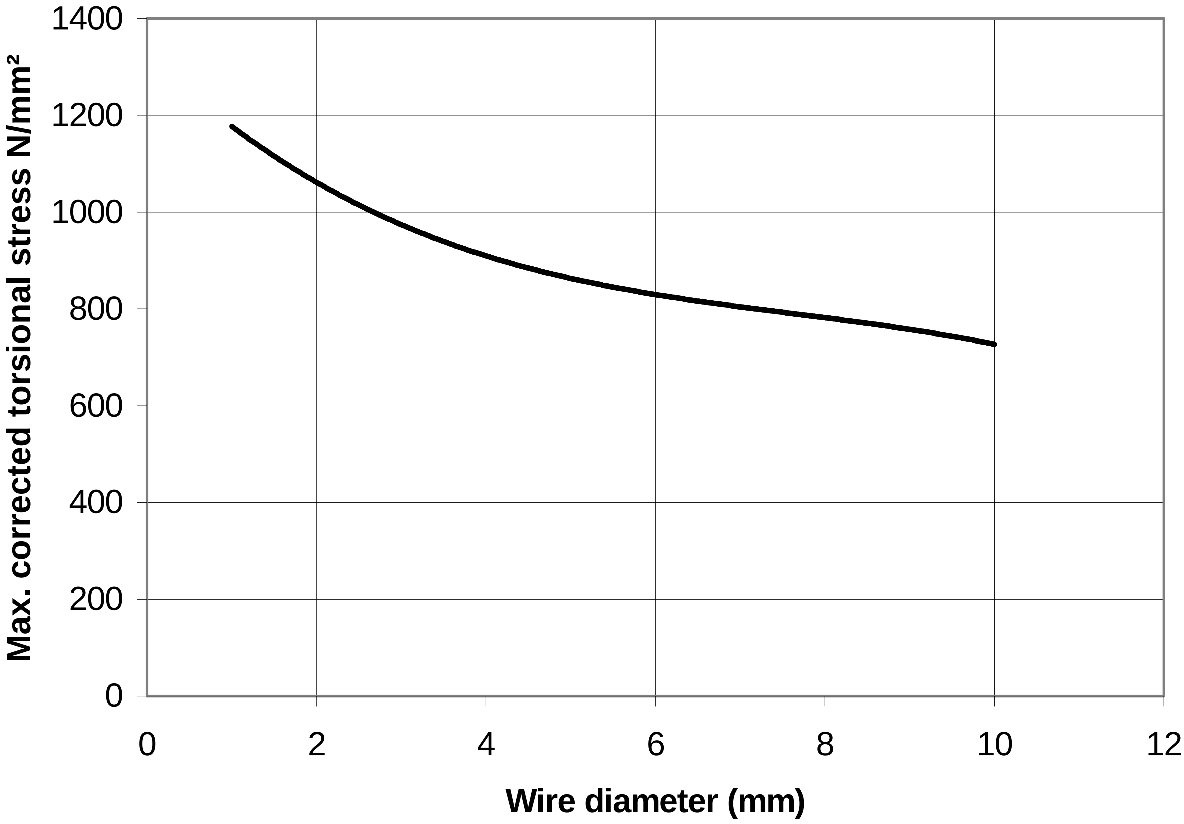

Figure 2 Maximum permissible static operating stresses for hard drawn patented wire EN 10270-1, SL low temperature heat treated and prestressed.

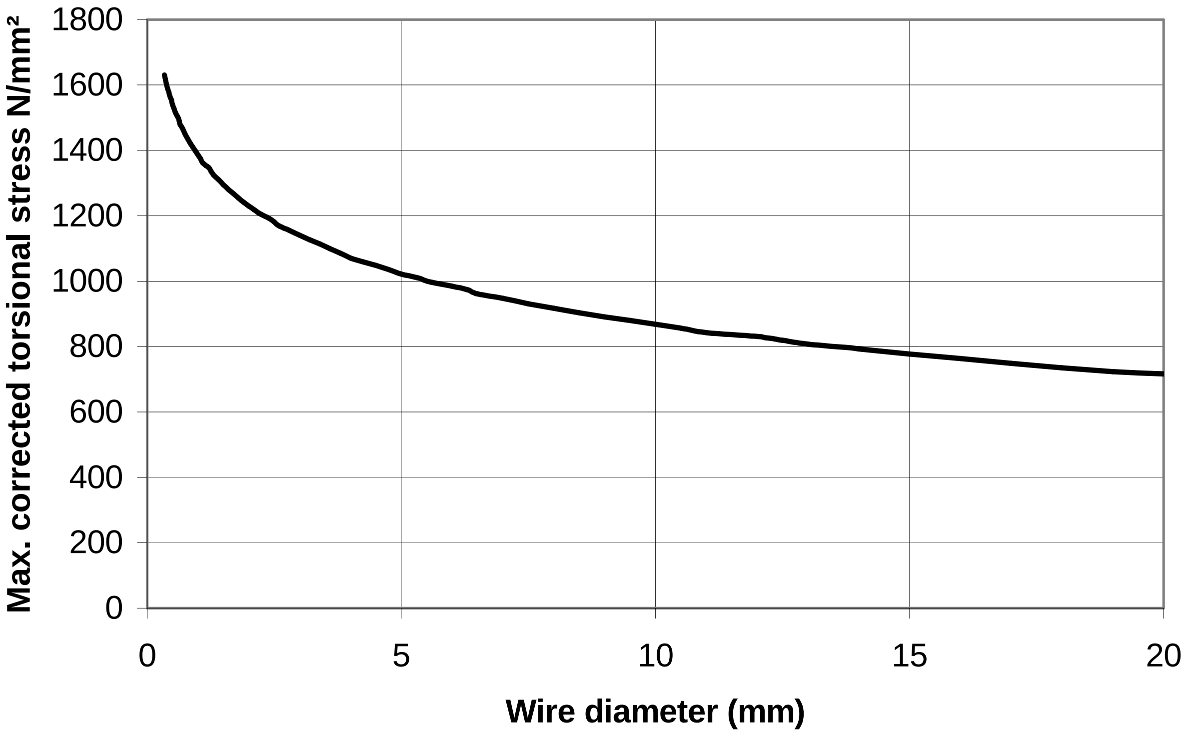

Figure 3 Maximum permissible static operating stresses for hard drawn EN 10270-1 SM&DM low temperature heat treated and prestressed.

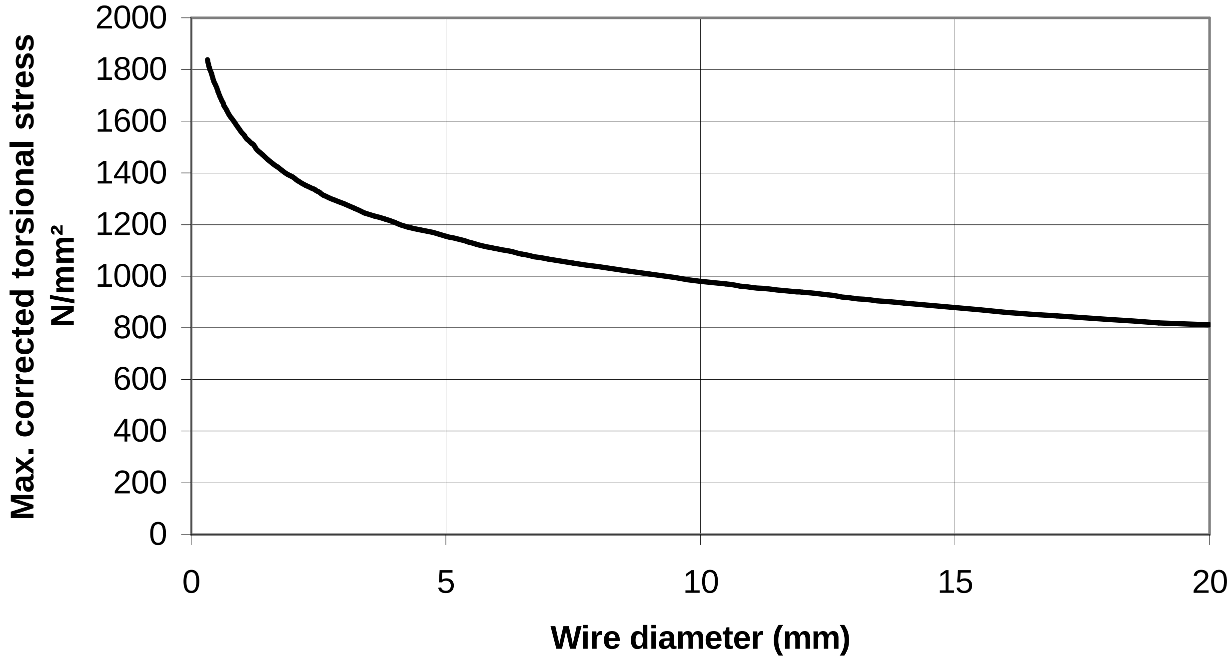

Figure 4 Maximum permissible static operating stresses for hard drawn EN 10270-1 SH low temperature heat treated and prestressed.

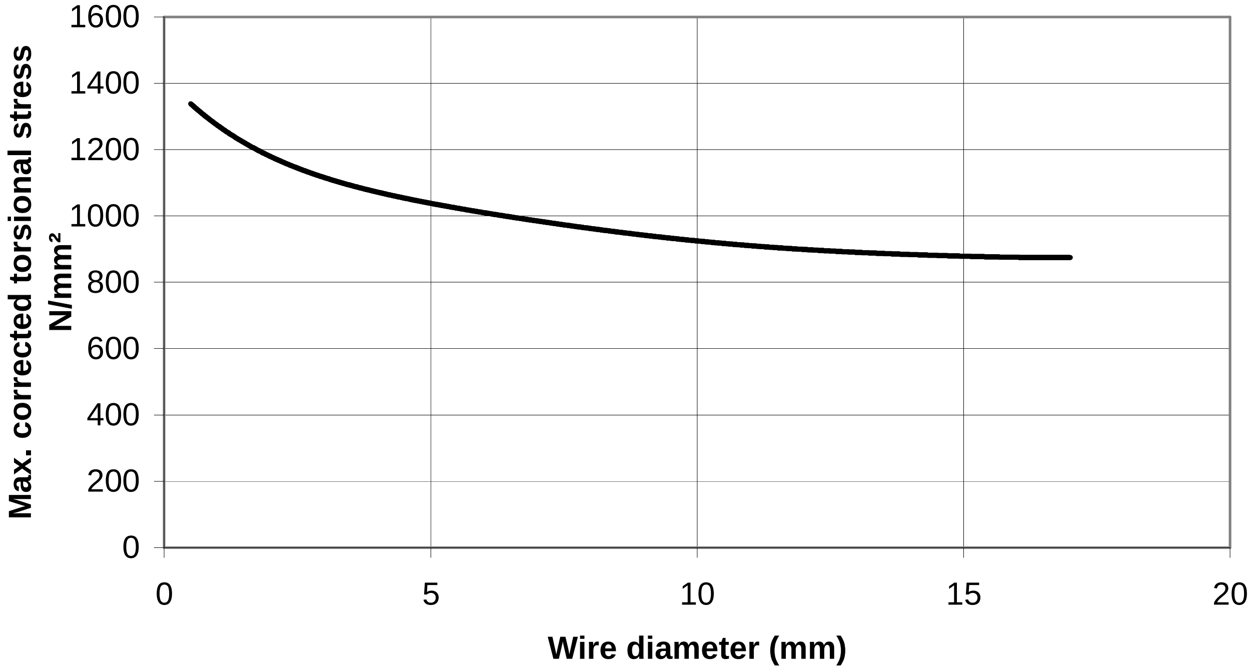

Figure 5 Maximum permissible static operating stresses for hardened and tempered carbon steel wire EN 10270-2 FDC low temperature heat treated and prestressed.

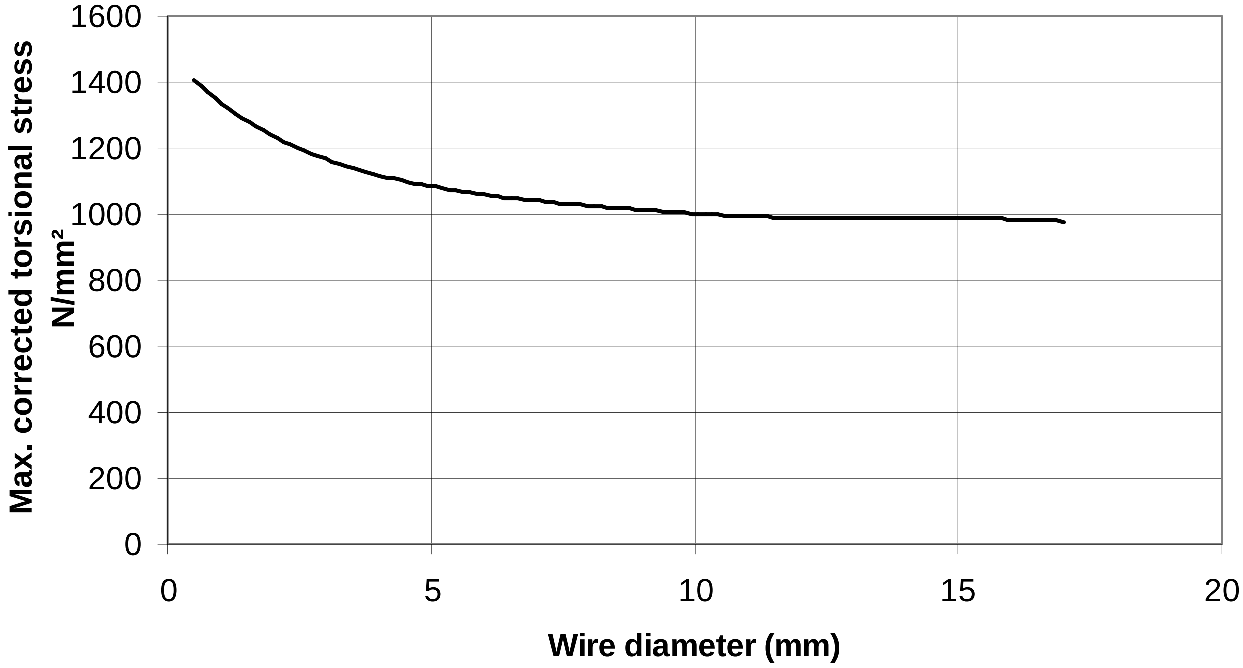

Figure 6 Maximum permissible static operating stresses for hardened and tempered chrome-vanadium steel wire EN 10270-2 FDCrV low temperature heat treated and prestressed.

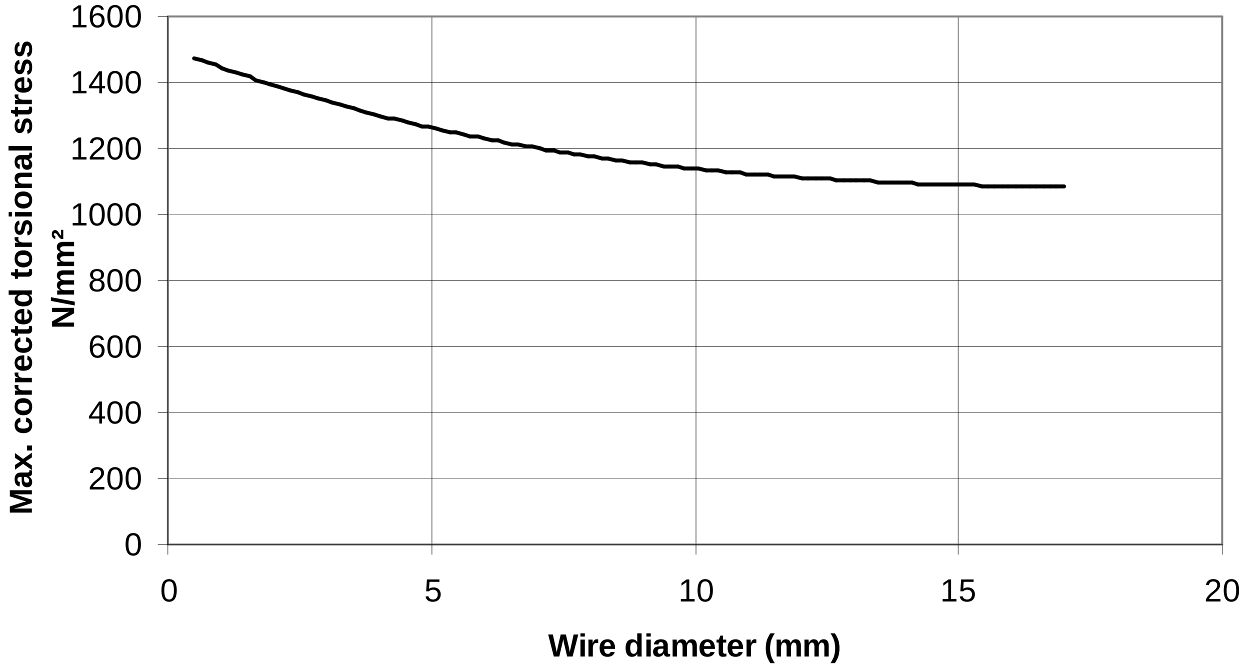

Figure 7 Maximum permissible static operating stresses for hardened and tempered silicon-chromium steel wire EN 10270-2 FDSiCr low temperature heat treated and prestressed.

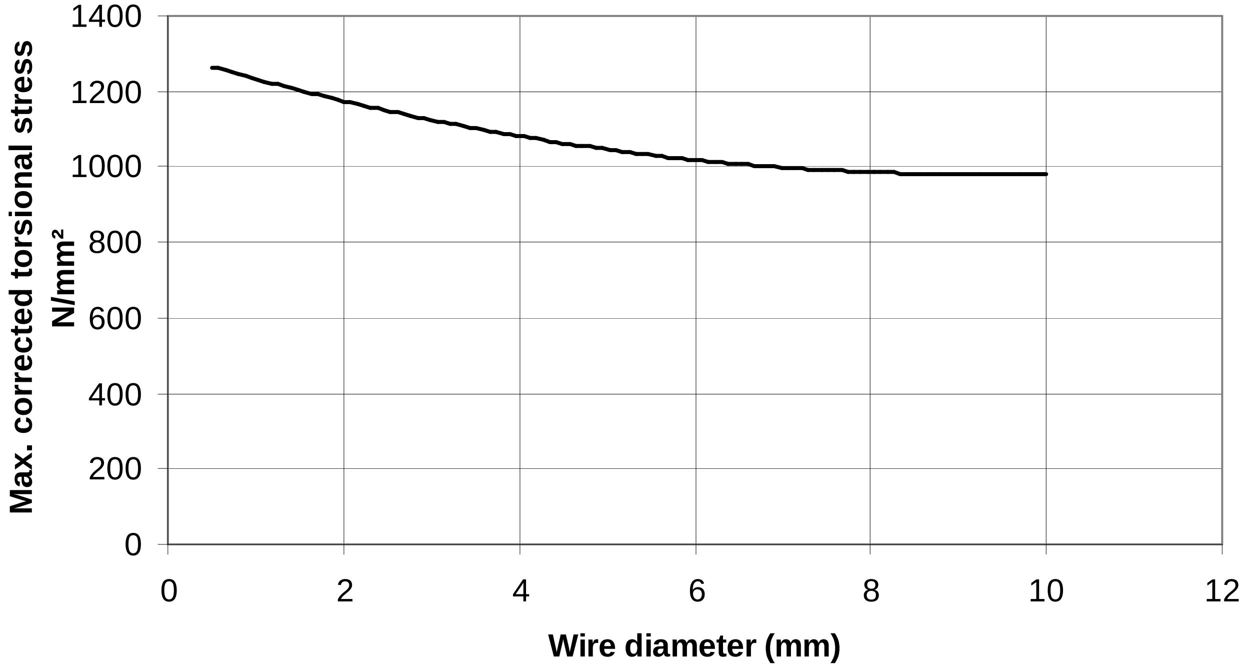

Figure 8 Maximum permissible static operating stresses for hardened and tempered carbon steel wire EN 10270-2 TDC&VDC low temperature heat treated and prestressed.

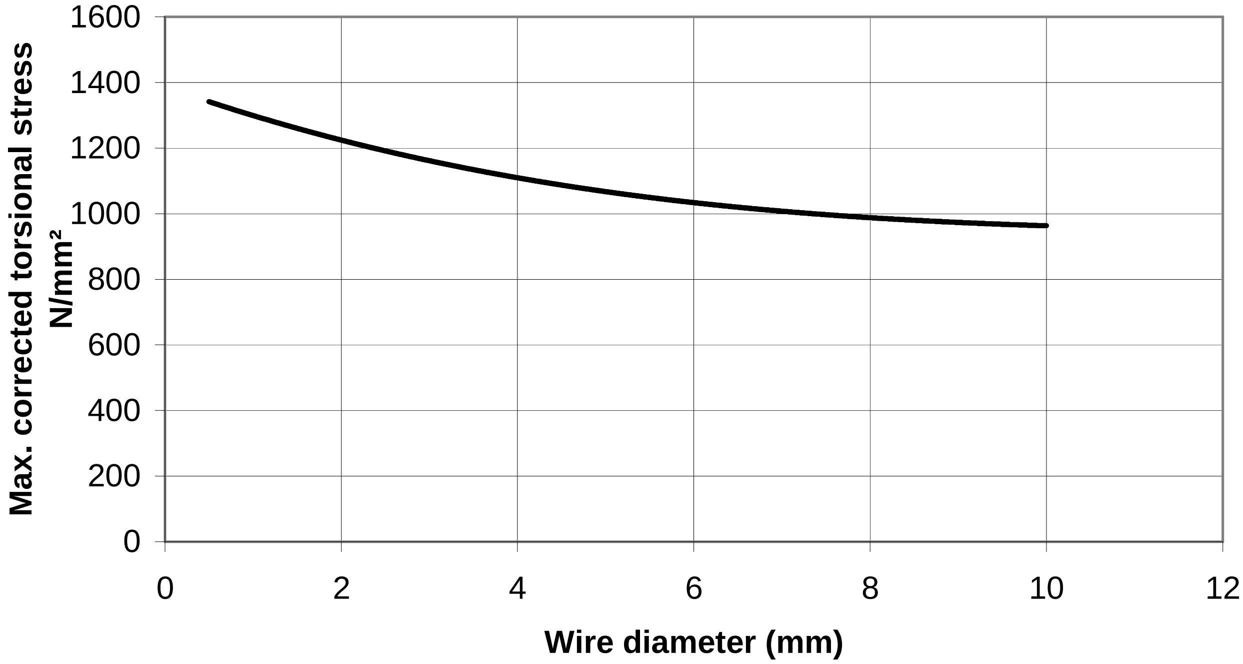

Figure 9 Maximum permissible static operating stresses for hardened and tempered chrome-vanadium steel wire EN 10270-2 TDCrV&VDCrV low temperature heat treated and prestressed.

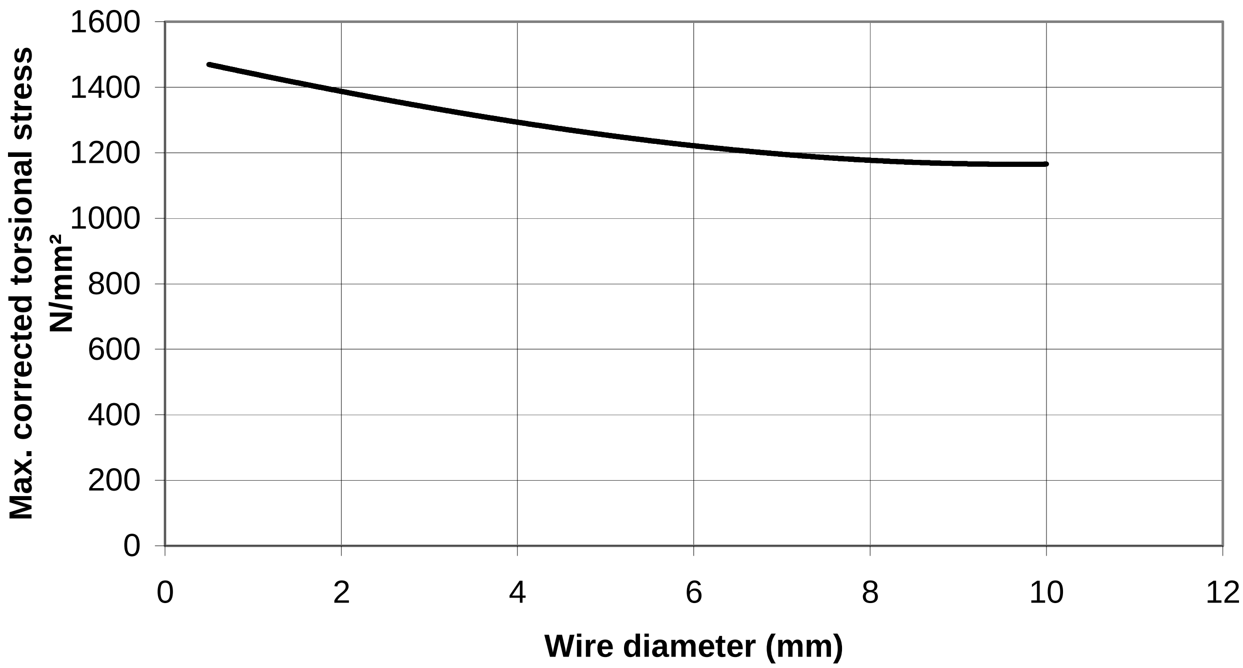

Figure 10 Maximum permissible static operating stresses for hardened and tempered silicon-chromium steel wire EN 10270-2 TDSiCr&VDSiCr low temperature heat treated and prestressed.

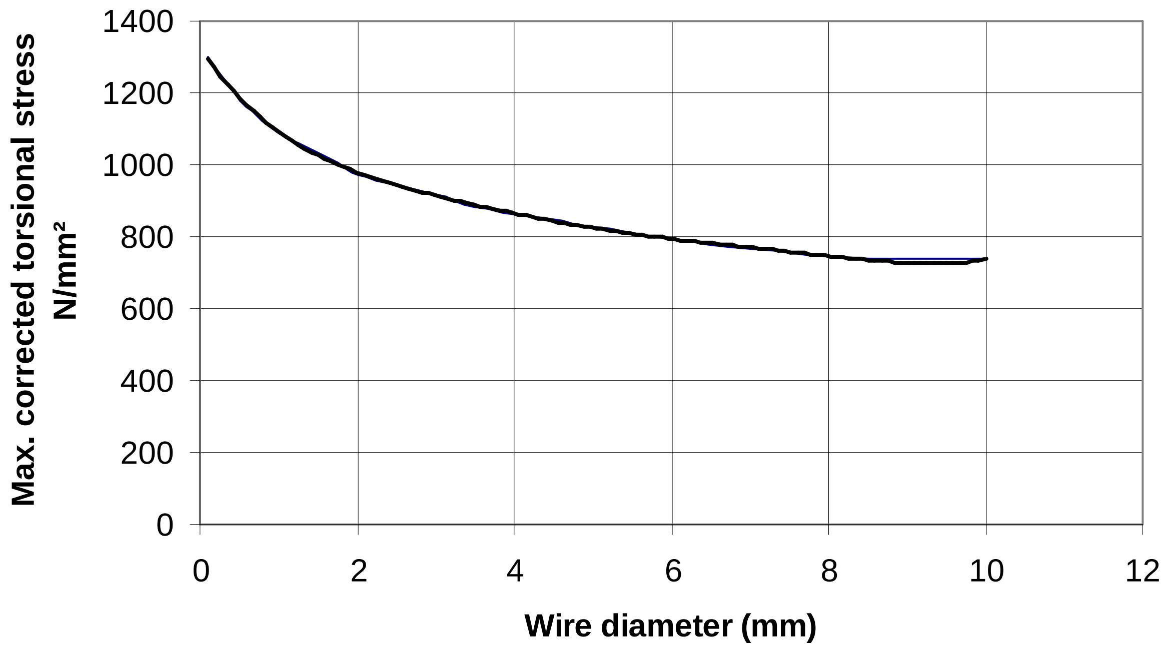

Figure 11 Maximum permissible static operating stresses for 18/8 stainless steel wire EN 10270-3, X10CrNi18-8 Normal low temperature heat treated and prestressed.

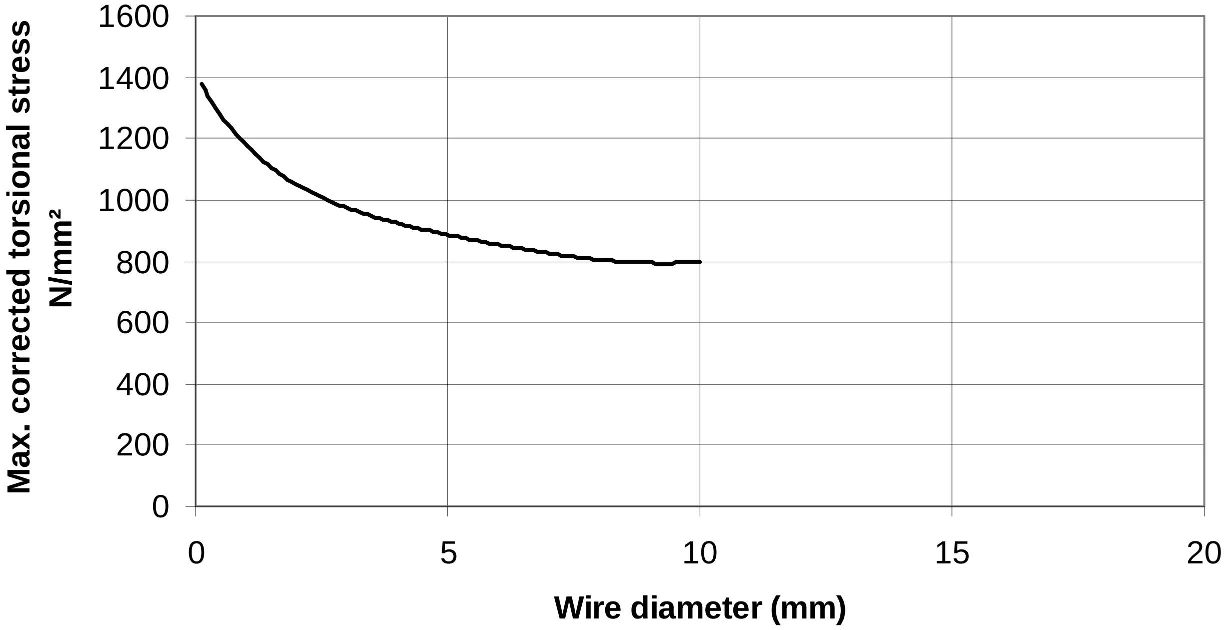

Figure 12 Maximum permissible static operating stresses for 18/8 stainless steel wire EN 10270-3, X10CrNi18-8 High Tensile low temperature heat treated and prestressed.

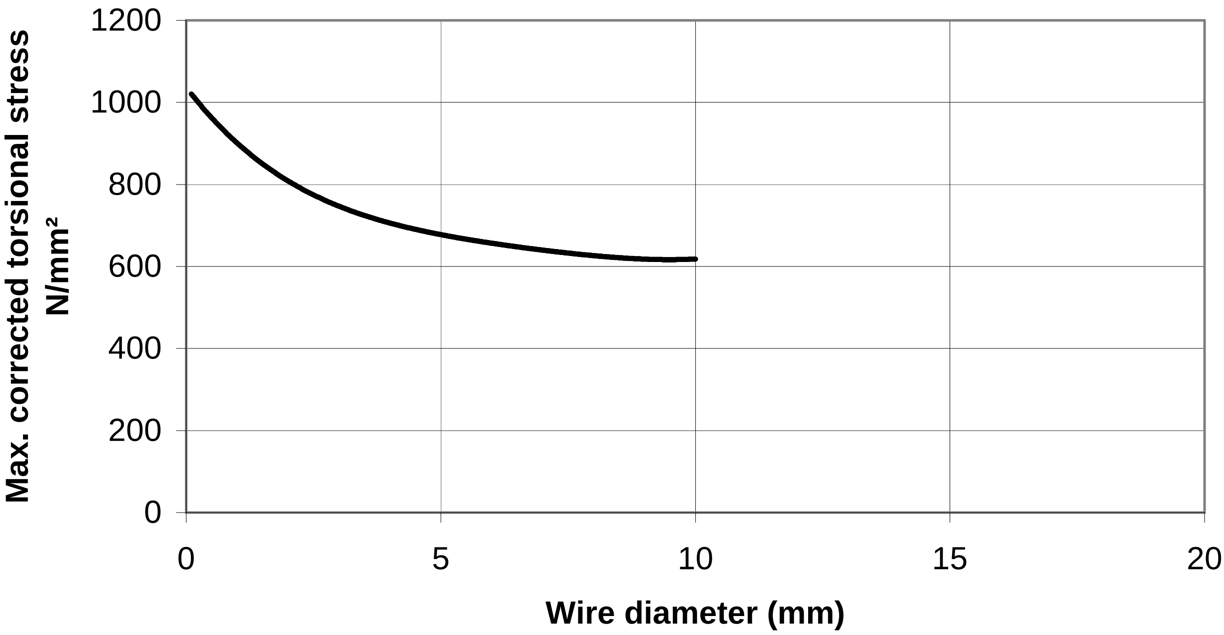

Figure 13 Maximum permissible static operating stresses for stainless steel wire EN 10270-3, X5CrNiMo17-12-2 low temperature heat treated and prestressed.

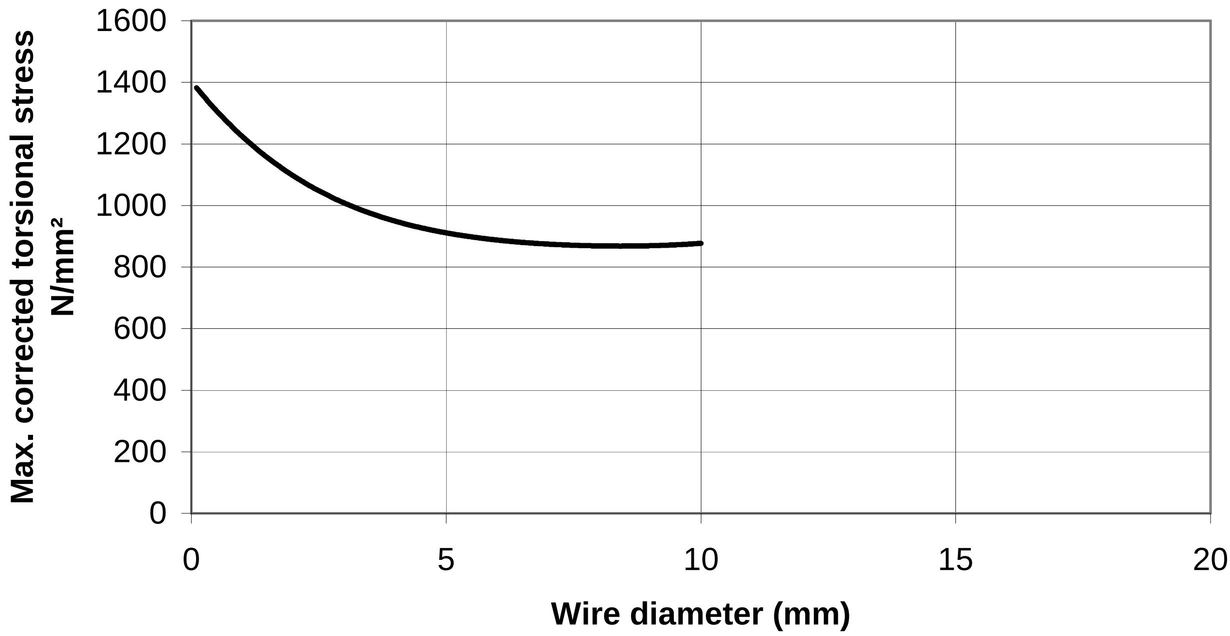

Figure 14 Maximum permissible static operating stresses for stainless steel wire EN 10270-3, X7CrNiAl17-7 low temperature heat treated and prestressed.

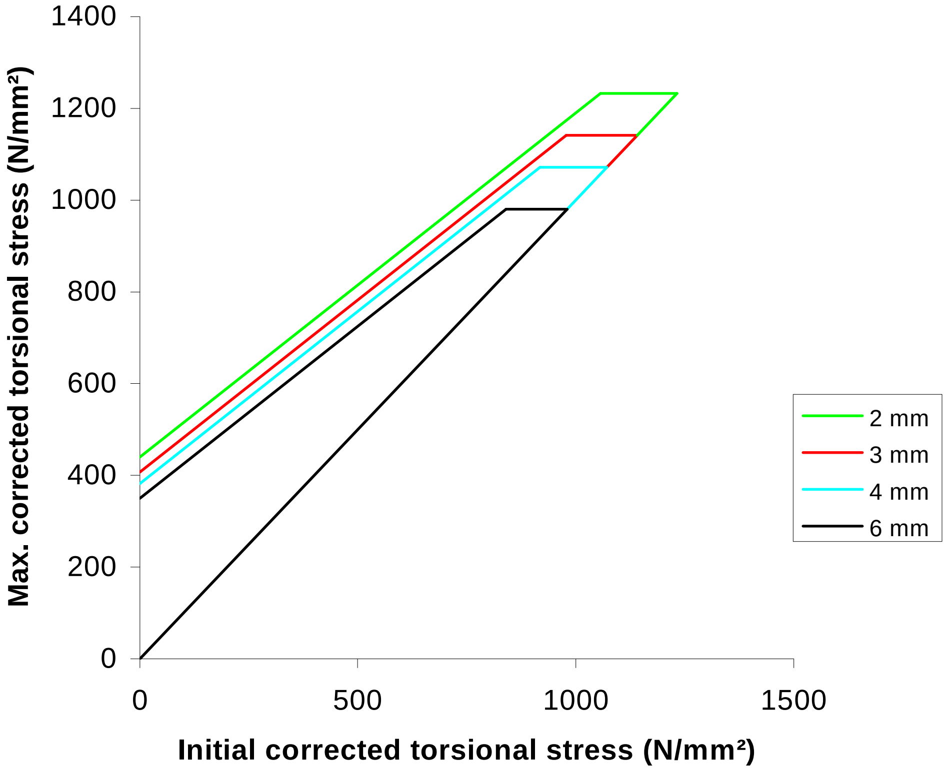

Figure 15 Fatigue diagram for unpeened, hard drawn patented wire, EN 10270-1 DM low temperature heat treated and prestressed. Showing the effect of torsional elastic limit.

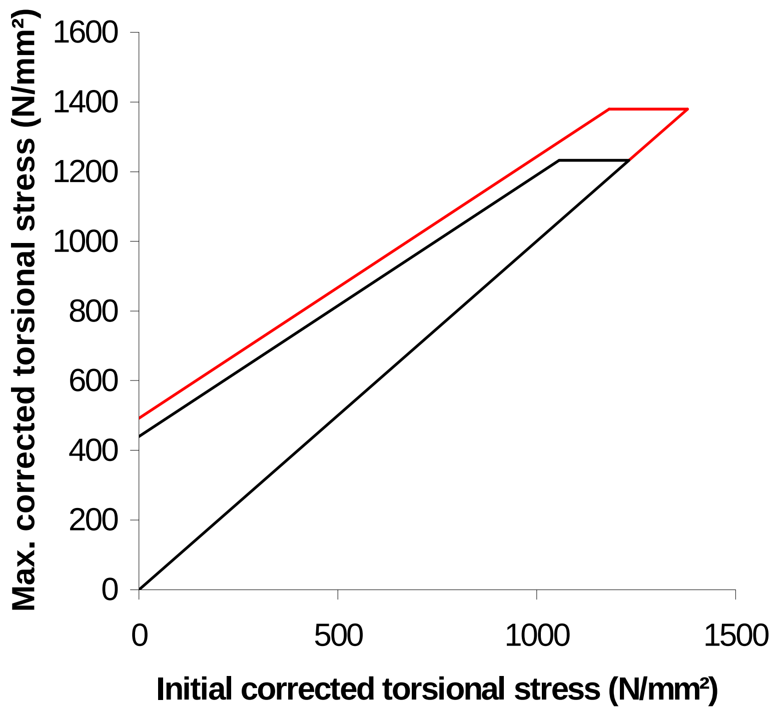

Figure 16 Fatigue diagram for unpeened, hard drawn patented wire, EN 10270-1 DM (range I), low temperature heat treated and prestressed. Showing the effect of tensile range.

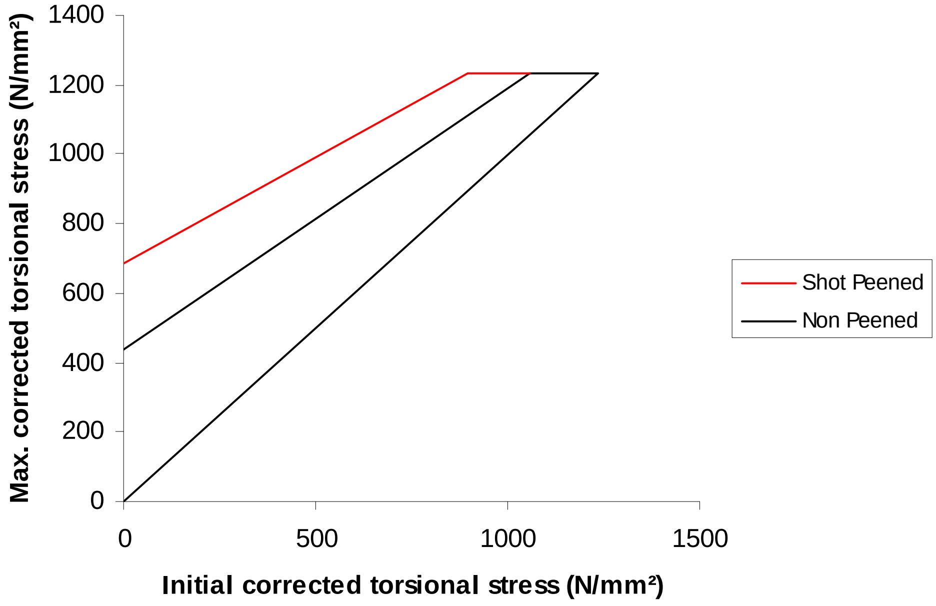

Figure 17 Fatigue diagram for hard drawn patented wire EN 10270-1 DM low temperature heat treated and prestressed. Showing the effect of shot peening.

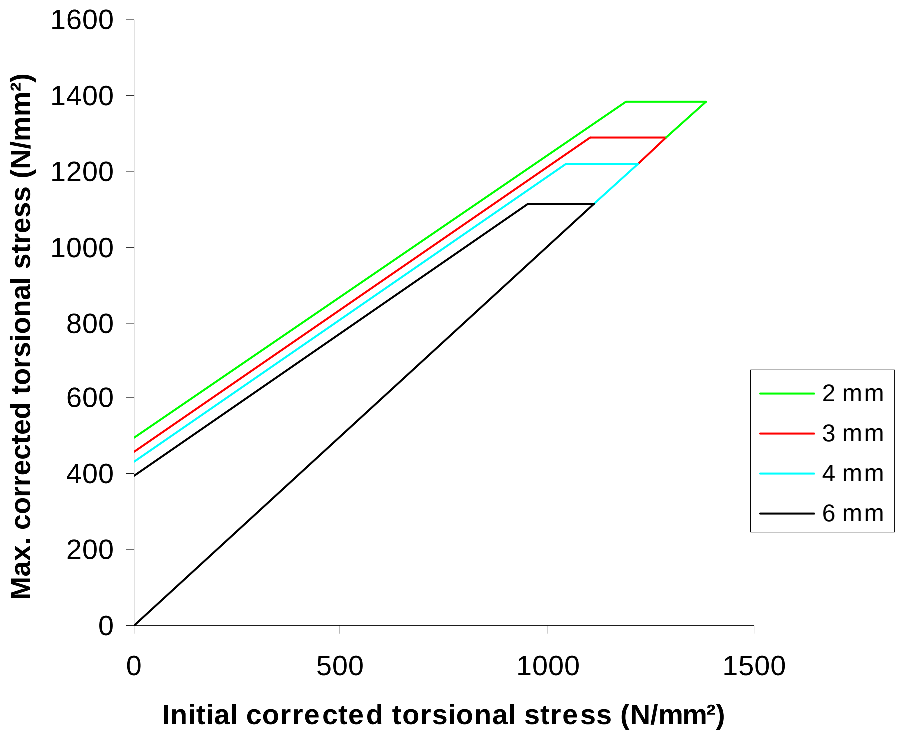

Figure 18 Fatigue diagram for unpeened, hard drawn patented wire, EN 10270-1 DH low temperature heat treated and prestressed. Showing the effect of torsional elastic limit.

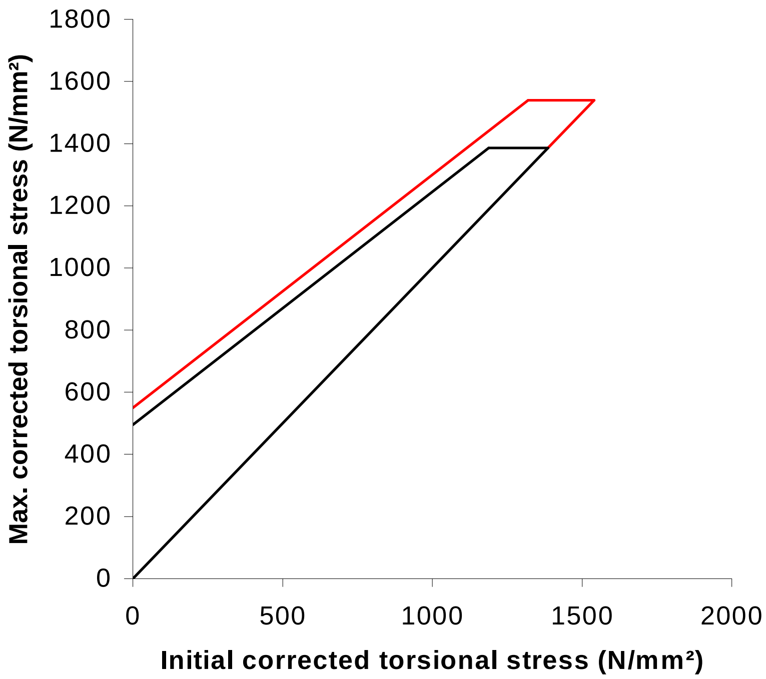

Figure 19 Fatigue diagram for unpeened, hard drawn patented wire EN 10270-1 DH low temperature heat treated and prestressed. Showing the effect of tensile range.

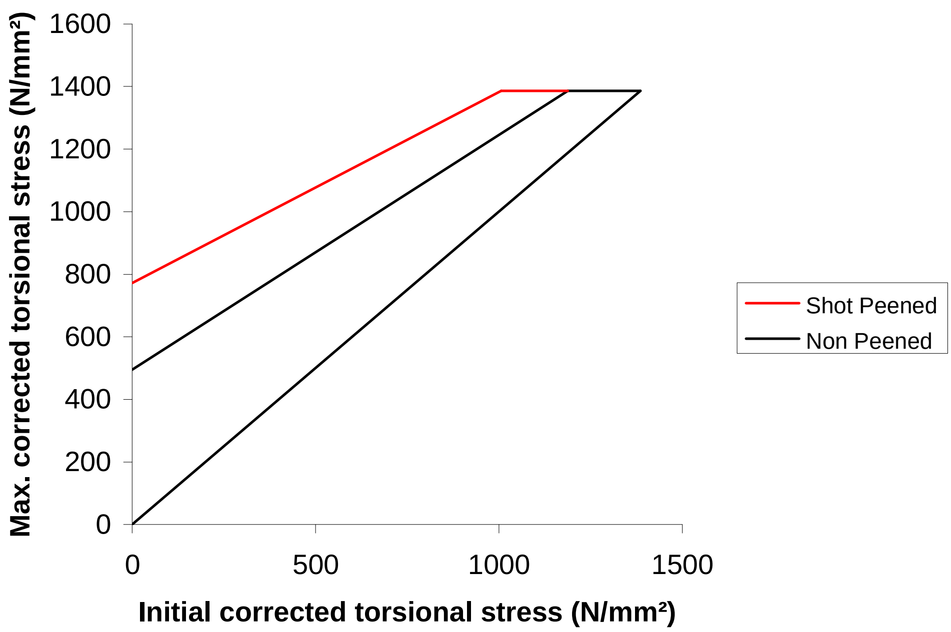

Figure 20 Fatigue diagram for hard drawn patented wire EN 10270-1 DH low temperature heat treated and prestressed. Showing the effect of shot peening.

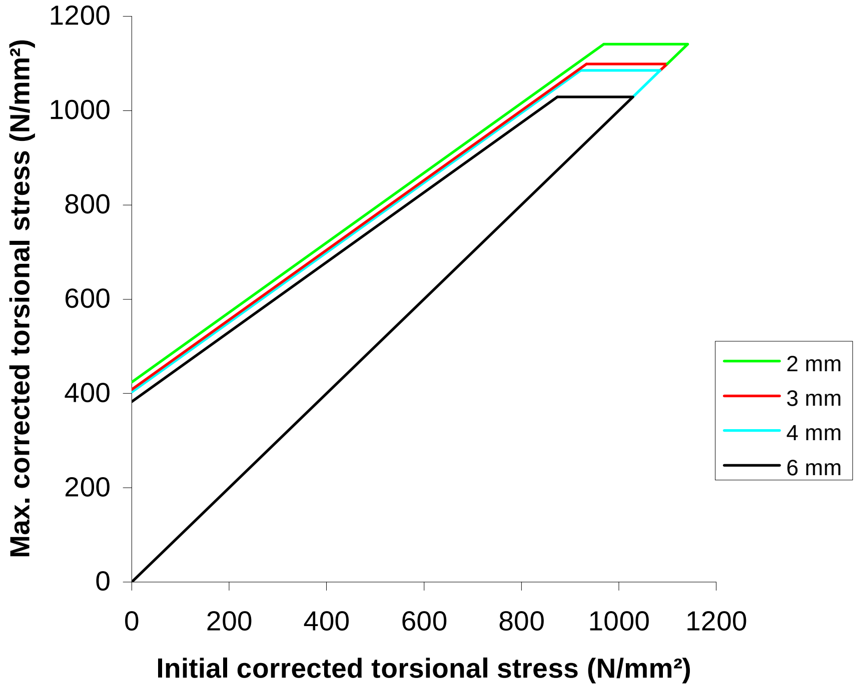

Figure 21 Fatigue diagram for unpeened, harden and tempered carbon steel wire EN 10270-2 TDC low temperature heat treated and prestressed. Showing the effect of torsional elastic limit.

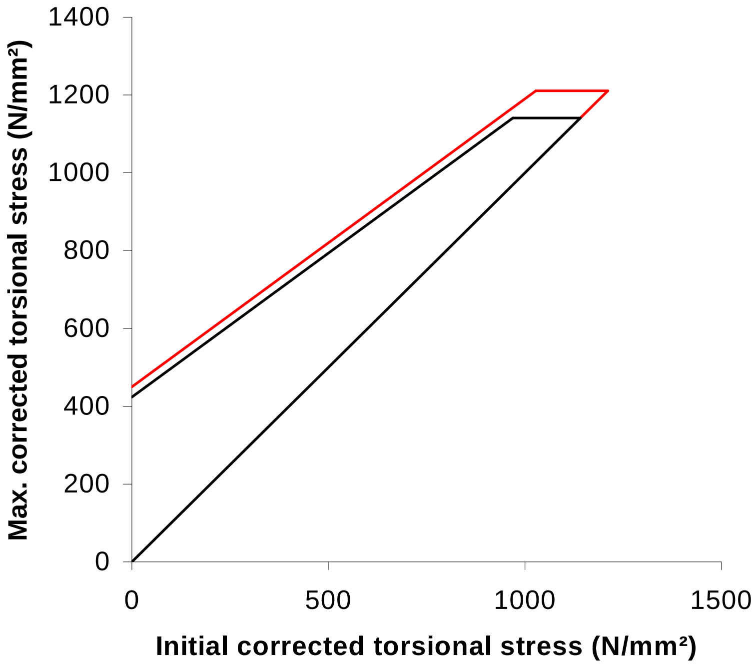

Figure 22 Fatigue diagram for harden and tempered carbon steel wire EN 10270-2 TDC low temperature heat treated and prestressed. Showing the effect of tensile range.

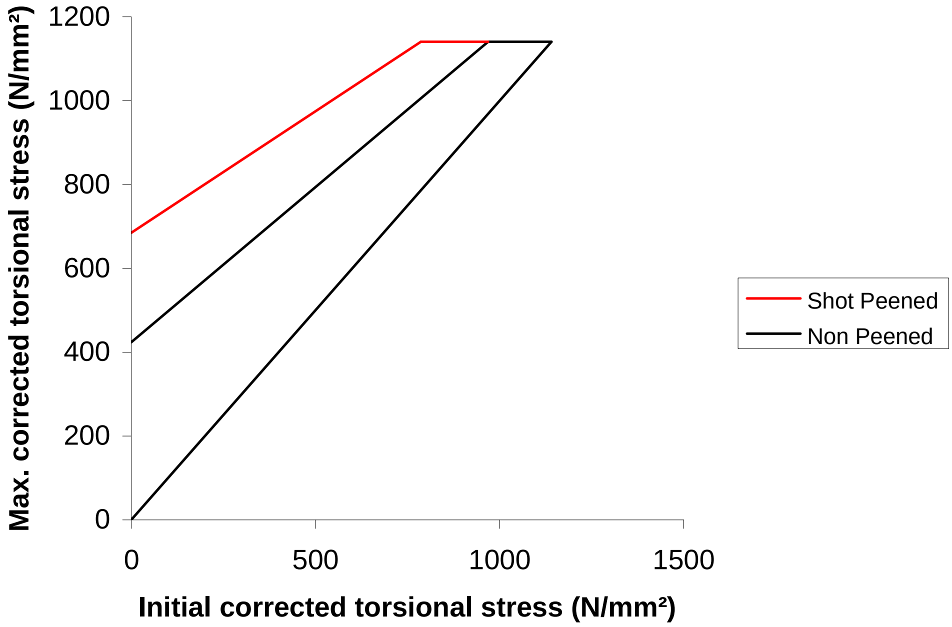

Figure 23 Fatigue diagram for harden and tempered carbon steel EN 10270-2 TDC low temperature heat treated and prestressed. Showing the effect of shot peening.

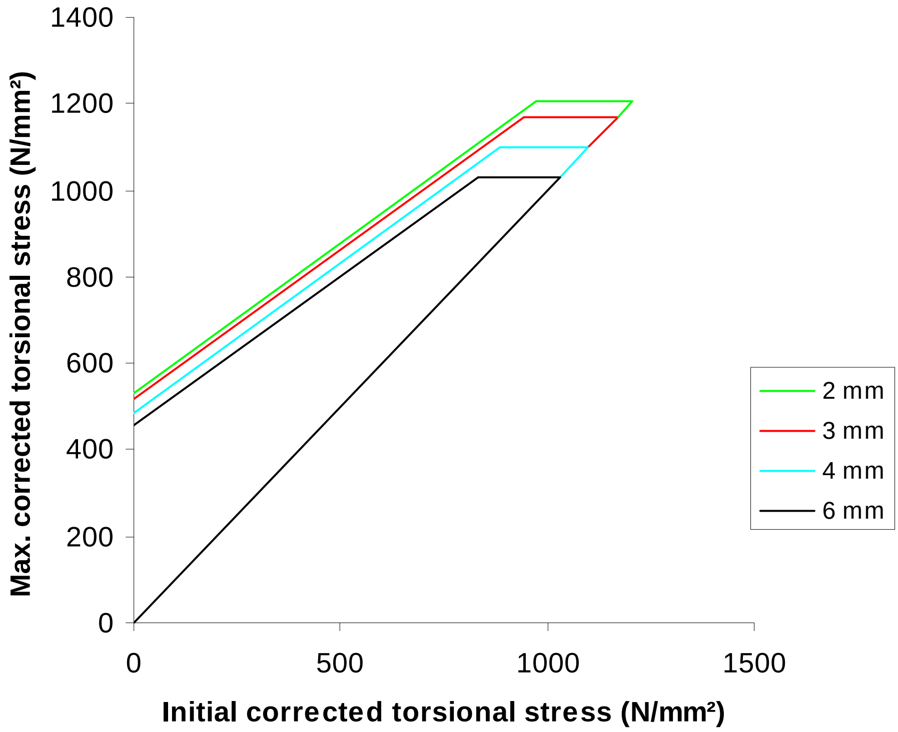

Figure 24 Fatigue diagram for harden and tempered chrome vanadium steel EN 10270-2 TDCrV low temperature heat treated and prestressed. Showing the effect of torsional elastic limit.

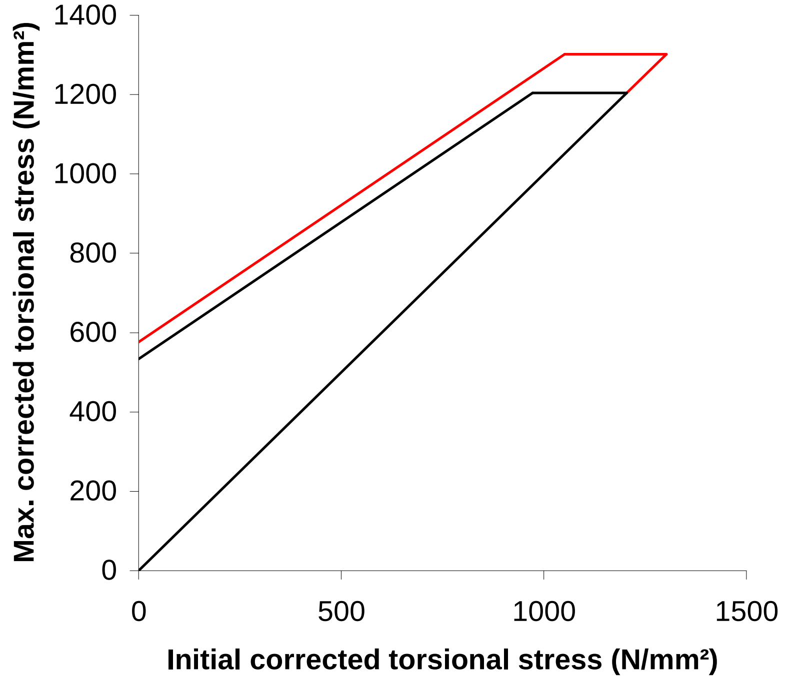

Figure 25 Fatigue diagram for harden and tempered chrome vanadium steel EN 10270-2 TDCrV low temperature heat treated and prestressed. Showing the effect of tensile range.

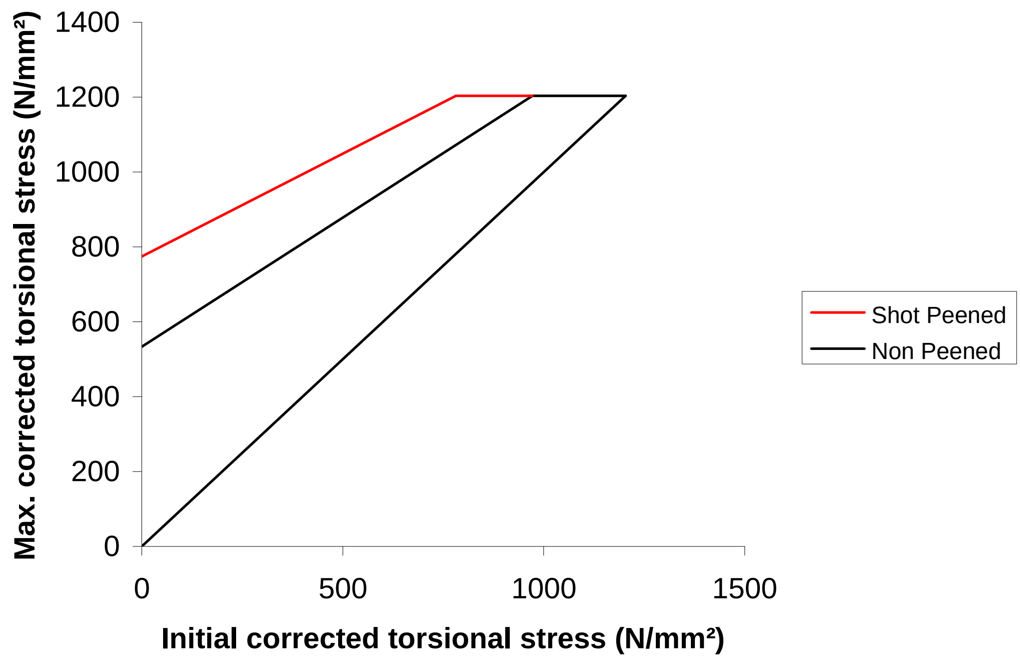

Figure 26 Fatigue diagram for harden and tempered chrome vanadium steel EN 10270-2 TDCrV low temperature heat treated and prestressed. Showing the effect of shot peening.

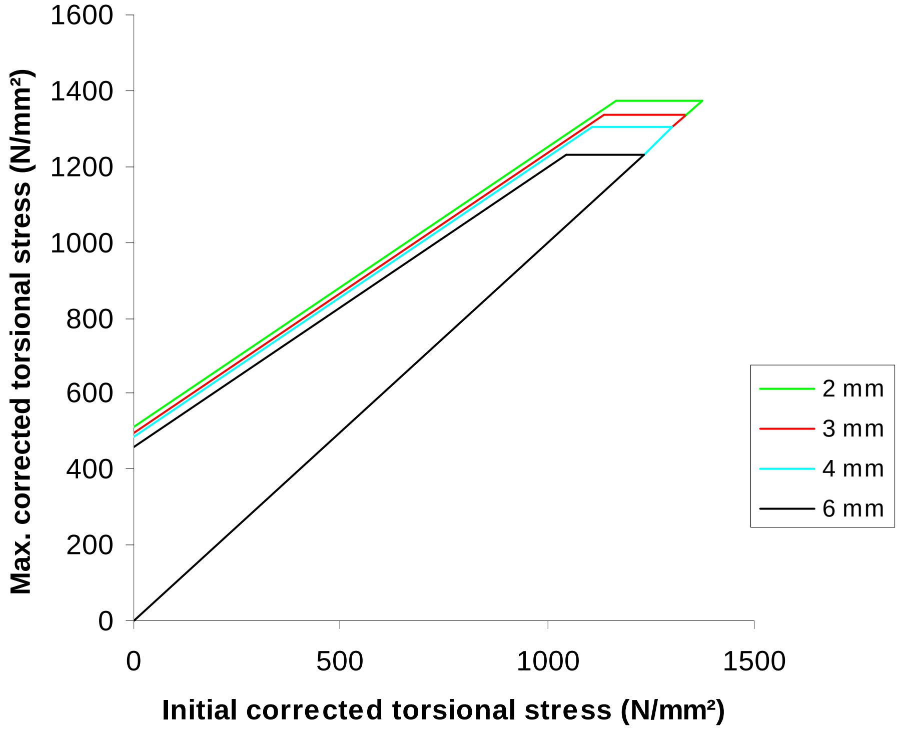

Figure 27 Fatigue diagram for unpeened harden and tempered silicon chrome steel EN 10270-2 TDSiCr low temperature heat treated and prestressed. Showing the effect of torsional elastic limit.

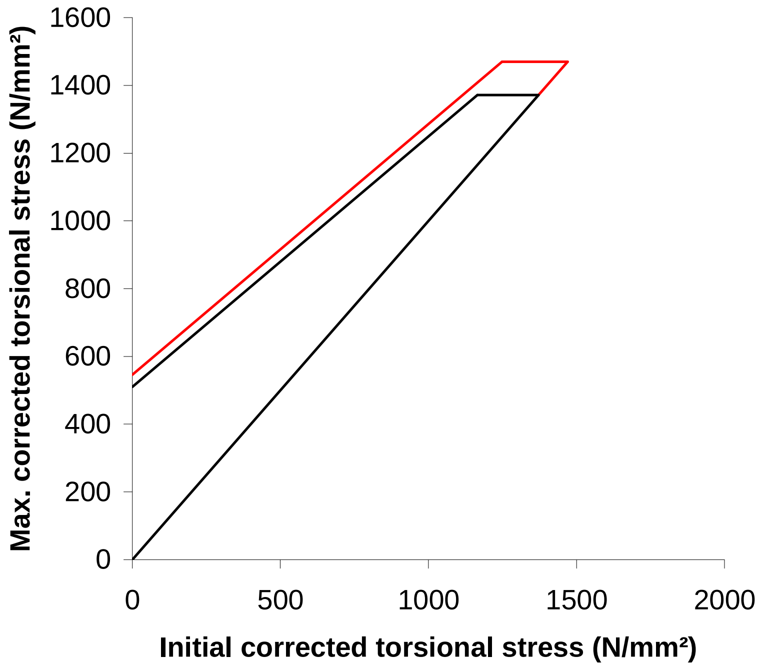

Figure 28 Fatigue diagram for unpeened harden and tempered silicon chrome steel EN 10270-2 TDSiCr low temperature heat treated and prestressed. Showing the effect of tensile range.

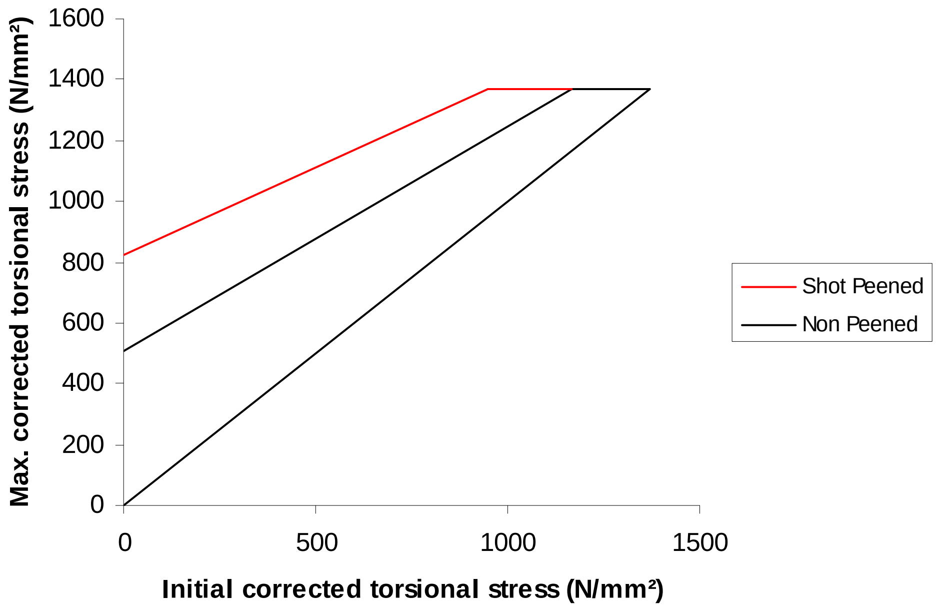

Figure 29 Fatigue diagram for unpeened harden and tempered silicon chrome steel EN 10270-2 TDSiCr low temperature heat treated and prestressed. Showing the effect of shot peening.

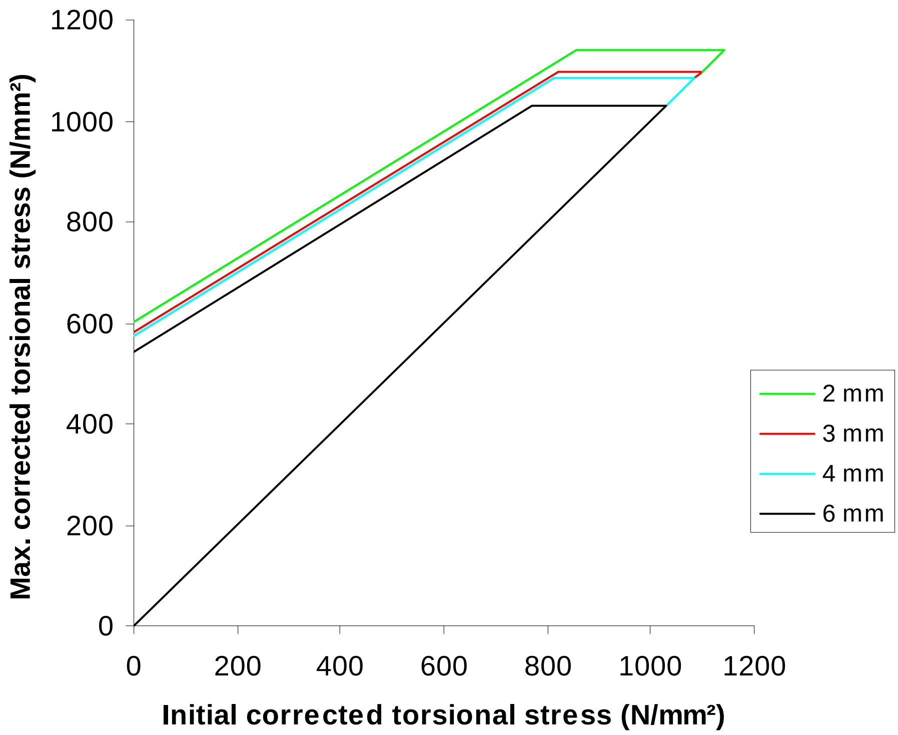

Figure 30 Fatigue diagram for harden and tempered carbon steel EN 10270-2 VDC low temperature heat treated and prestressed. Showing the effect of torsional elastic limit.

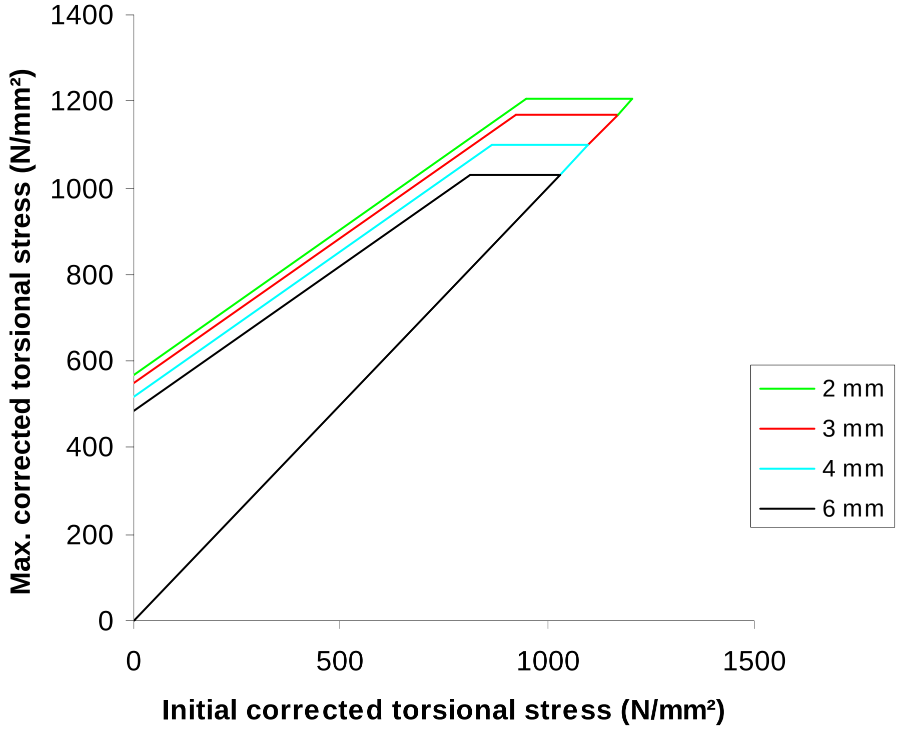

Figure 31 Fatigue diagram for harden and tempered chrome vanadium steel EN 10270-2 VDCrV low temperature heat treated and prestressed. Showing the effect of torsional elastic limit.

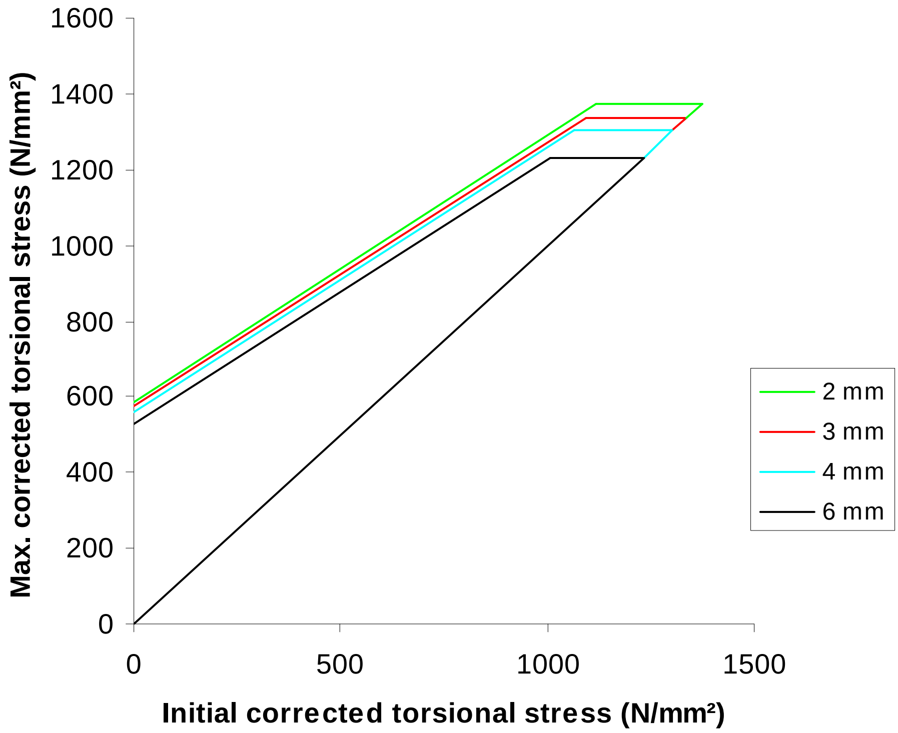

Figure 32 Fatigue diagram for harden and tempered silicon chrome EN 10270-2 VDCiCr low temperature heat treated and prestressed. Showing the effect of torsional elastic limit.