Annex 1

Conventions

Yellow color	Input data
Blue color	Results

Input data

AGMA

$\mathbf{z} := 45$	Number of teeth in spline
$\mathbf{T} := 30000$	Applied torque, Nm
$\mathbf{d} := 285$	Diameter at half working depth, mm
$\mathbf{b_i} := 25$	Spline effective length, mm
$\mathbf{K_m} := 1$	Load distribution factor,

Dudley

$\mathbf{N} := \mathbf{z}$

$\mathbf{D} := \mathbf{d}$

$\mathbf{F} := \mathbf{b_i}$

$$\mathbf{t_c} := \frac{\mathbf{d}}{2 \cdot \mathbf{N}}$$

Calculation of shear stress

AGMA 6123-C16
Eq. 39 re-written for shear stress, Nm

$$s_{sa} := \frac{T \cdot 8000 \cdot K_m}{\pi \cdot d^2 \cdot b_i}$$

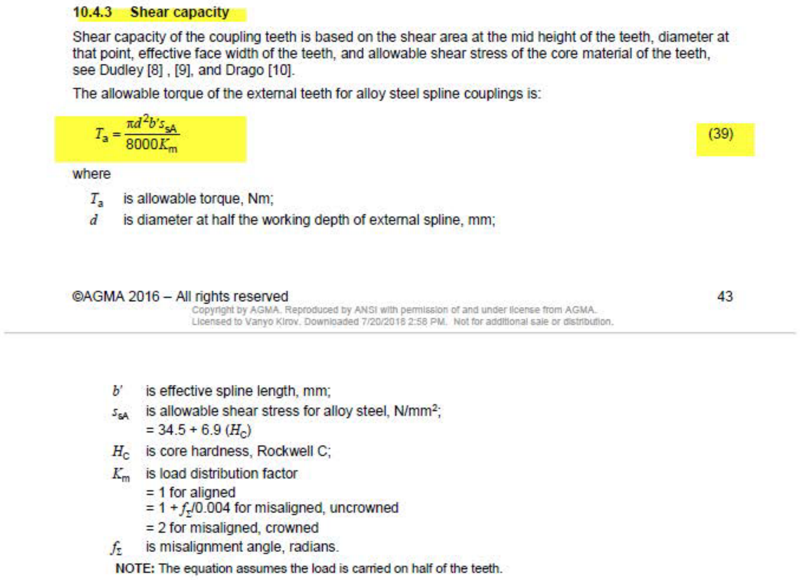
$$s_{sa} = 37.621$$

Dudley
Eq 4 from paper "When splines need stress control", Nm

$$S_c := \frac{4 \cdot T \cdot K_m \cdot 1000}{D \cdot N \cdot F \cdot t_c}$$

$$S_c = 118.19$$

AGMA source



10.4.3 Shear capacity

Shear capacity of the coupling teeth is based on the shear area at the mid height of the teeth, diameter at that point, effective face width of the teeth, and allowable shear stress of the core material of the teeth, see Dudley [8] , [9], and Drago [10].

The allowable torque of the external teeth for alloy steel spline couplings is:

$$T_a = \frac{\pi d^2 b' s_{sA}}{8000 K_m} \qquad (39)$$

where

T_a is allowable torque, Nm;

d is diameter at half the working depth of external spline, mm;

b' is effective spline length, mm;

s_{sA} is allowable shear stress for alloy steel, N/mm^2;
= 34.5 + 6.9 (H_C)

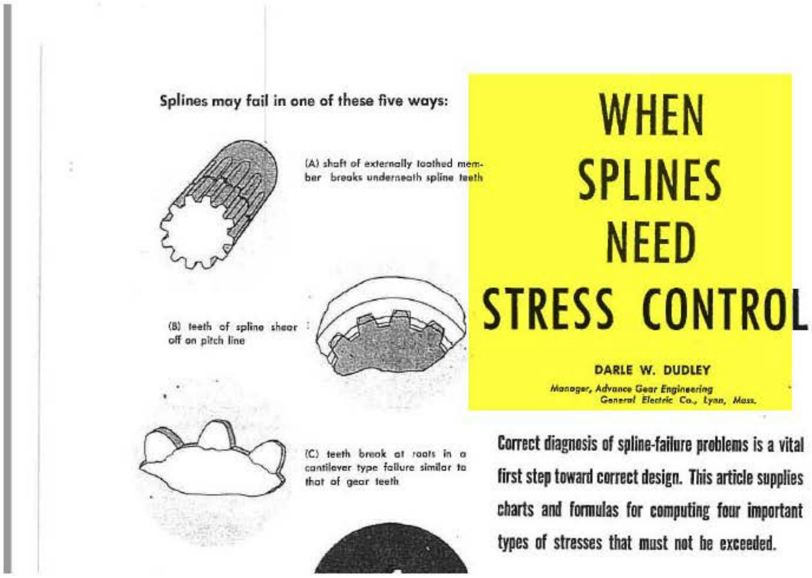
H_C is core hardness, Rockwell C;

K_m is load distribution factor
= 1 for aligned
= 1 + f_Σ/0.004 for misaligned, uncrowned
= 2 for misaligned, crowned

f_Σ is misalignment angle, radians.

NOTE: The equation assumes the load is carried on half of the teeth.

Dudley source



Splines may fail in one of these five ways:

(A) shaft of externally toothed member breaks underneath spline teeth

(B) teeth of spline shear off on pitch line

(C) teeth break at roots in a cantilever type failure similar to that of gear teeth

WHEN SPLINES NEED STRESS CONTROL

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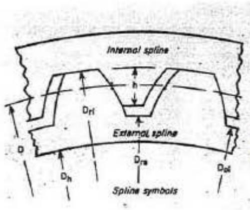
Correct diagnosis of spline-failure problems is a vital first step toward correct design. This article supplies charts and formulas for computing four important types of stresses that must not be exceeded.

(D) contacting surface of spline teeth wear away by fretting corrosion

(E) shell of the internally toothed member ruptures



Spline symbols

SPLINE SYMBOLS

A	height of crown
B	misalignment of spline, in./in.
D	pitch dia, in.
D_h	bore dia of shaft, in.
D_{oi}	outside dia of internally toothed part, in.
D_{ri}	major dia of internally toothed part, in.
D_{re}	root dia, also minor dia of external toothed member, in.
F	full face width, in.
F_e	effective face width, in. (may be less than F; see Editor's Note)
h	radial height of the tooth in contact, in.
K_a	application factor
K_m	load distribution factor
L_f	life factor limited by fatigue
L_w	life factor limited by wear
n	rpm
N	number of spline teeth
S_c	compressive stress, psi
S'_c	allowable compressive stress, psi
S_s	shear stress, psi
S'_s	allowable shear stress, psi
S_t	total stress, psi
t_c	chordal thickness at pitch line, in. (approximately equal to $D/2N$)
t_w	wall thickness, in.
T	torque, in.-lb = 63,000 hp/n
ϕ	pressure angle, deg

induced shear stresses are:

$$S_s = \frac{4TK_m}{DNF_e t_c} \qquad (4)$$

In a spline, contrasted with a gear, tooth failure cannot stop the drive until all teeth are broken on both members. The constant 4 in the above equation assumes that, because of spacing errors, only half the teeth carry the load. With poor manufacturing accuracies, it is best to increase the factor to 6. Values for load distribution factor K_m, given in Table IV, are based on the amount of misalignment; K_m is 1.0 for a fixed spline (misalignment in a fixed spline is zero).

After calculating tooth shear stress, Eq (3) can again be used—to relate the calculated stresses with the allowable stresses.