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A-41
10/1/84

Rules and Regulations for the Classification of Ships

Part 5

Main and Auxiliary Machinery

Chapter 2

Oil Engines

July 1982

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SECTION 3
Crankshafts

[redacted]

3.1.1 The power rating of the engine is not to exceed that given by the following formula:—

$$\frac{P_o}{R_o} = \frac{nE}{765\,CK_1}\left[\frac{d^3Z\,(\sigma_u+160)}{700\,000} - \frac{AK_2p\,(l-l_p)\,D^2}{100\,000}\right] -$$

$$\left(\frac{H_o}{R_o} = \frac{nE}{5730\,CK_1}\left[\frac{d^3Z\,(\sigma_u+16)}{7000} - \frac{AK_2p\,(l-l_p)\,D^2}{100\,000}\right]\right)$$

NOTE. The power rating $\frac{P_o}{R_o}\left(\frac{H_o}{R_o}\right)$ is to be not less than the power rating based on $P(H)$ and R as defined in Ch 1 3.3.

where

P_o = maximum designed shaft power, in kW,
(H_o = maximum designed shaft power, in shp),
R_o = rev/min of the crankshaft at maximum designed shaft power,
n = number of cylinders for 2SCSA engines,
= half the number of cylinders for 4SCSA engines,
E = mechanical efficiency of the engine expressed as a decimal,
A and C = coefficients from Tables 2.3.1, 2.3.2, 2.3.3, 2.3.4 or 2.3.5 for appropriate cycle and firing order with equal intervals between firing (cylinders numbered from the free end of the engine),

$K_1 = 0{,}8 + \frac{u}{3d_p} + 0{,}243\sqrt{\frac{d_p}{r}}$ for solid forged steel or cast iron crankshafts and the combined pins and webs of semi-built forged or cast steel crankshafts,

= 1,8 for shrunk sections of forged or cast steel semi-built and built crankshafts,

d_p = diameter of crankpin, in mm,
r = fillet radius at junction of crankweb with crankpin, in mm. (The fillet radius at junction of journal and crankweb is not to be less than r),
$u = d_p + d_j - S$
d_j = diameter of crank journal, in mm,
S = length of stroke, in mm,
d = minimum diameter of crankshaft pin or journal, whichever is less, or equivalent diameter for hollow shafting, in mm,
Z = 1,0 except as follows:—
= 1,15 for die-forged crankshafts and continuous grain-flow crankshafts where these methods of manufacture or processing have been specially approved,
= 1,25 for crankshafts surface-hardened by nitriding where full particulars of the method and process have been approved.

NOTE. Special consideration will be given to other surface-hardening treatments which include the fillet radii, in allocating an appropriate Z value. If it can be proved that any surface-hardening process will further improve the fatigue characteristics of die-forged or continuous grain-flow crankshafts, consideration will be given to the use of a combined Z value,

$= \frac{\sigma_u + 260 - 0{,}059d}{1{,}23\,(\sigma_u + 160)}$ $\left(\frac{\sigma_u + 26{,}5 - 0{,}006d}{1{,}23\,(\sigma_u + 16)}\right)$ for cast iron crankshafts,

σ_u = specified minimum tensile strength of crankshaft material, in N/mm² (kgf/mm²),
K_2 = 7,0 for shrunk sections of forged or cast steel semi-built and built crankshafts,

$= QFG\sqrt{\frac{d_p}{r}}$ for solid forged steel or cast iron crankshafts and the combined pins and webs of semi-built forged or cast steel crankshafts,

Q = coefficient from Fig. 2.3.1.
NOTE. Q is to be taken as 1,0 for all negative values of $\frac{u}{d_p}$ greater than 0,6,

m = depth of recess of fillet into crankweb, in mm,
F = coefficient from Fig. 2.3.2,
b = breadth of web, in mm,
G = coefficient from Fig. 2.3.3 or Fig. 2.3.4,
t = axial thickness of web, in mm,
p = maximum combustion pressure, in N/mm² (kgf/cm²), at maximum designed shaft power,
l = span of bearings adjacent to a crank measured from inner edge to inner edge, in mm,
l_p = length of crankpin, in mm,
D = diameter of cylinder, in mm.

3.1.2 Engines having unequal firing intervals, or not covered by values of A and C given in Tables 2.3.1, 2.3.2, 2.3.3, 2.3.4 or 2.3.5 and Vee engines having different firing orders on each bank, will receive special consideration.

3.1.3 For Vee engines having minimum firing intervals between two cylinders on one pin different from those given in Tables 2.3.3, 2.3.4 or 2.3.5, the values of A and C may be obtained by interpolation.

3.1.4 In designs of crankshafts to which the engine power rating formula is not directly applicable, detailed design calculations are to be submitted for special consideration.

3.1.5. Special consideration will be given to cast iron crankshafts which have been designed and developed for optimum fatigue strength with cranks of the most favourable shape, and some allowance made for the superior strength thereby obtained. Particulars of any relevant tests or experience should be submitted.

3.2 Crankwebs of built and semi-built steel shafts

3.2.1 Where the crankwebs are shrunk on crankpins or journals, the dimensions and yield stress of the material of the crankwebs are not to be less than given by the following formulæ for the shrinkage allowance proposed:—

$$t = \frac{d_j^3\,(d_o + 2h)^3}{6580S_1\,k\,d_o\,h\,(d_o + h)}\ \text{mm}$$

$$\sigma_o = 92\,200S_1\frac{k}{d_o}\left[1 + \left(\frac{d_j}{d_o + 2h}\right)^3\right]\ \text{N/mm}^2$$

$$\left(\sigma_o = 9400S_1\frac{k}{d_o}\left[1 + \left(\frac{d_j}{d_o + 2h}\right)^3\right]\ \text{kgf/mm}^2\right)$$