Studlink and Studless Fatigue Curves for Mooring Lines

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1 Introduction

This report summarizes the derivation of fatigue curves for studless and studlink chain mooring lines for inclusion in API 2SK, Third Edition. The second edition of API 2SK [1] has a single fatigue curve for mooring chain, this curve is a non-unique lower bound to all of the in-water and in-air studlink fatigue test data. API 2SK, Second Edition, does not have separate fatigue curves for studlink and studless chain.

The studlink fatigue curve derived in this report is based on the saltwater tension-tension fatigue tests performed by the National Engineering Laboratory, Glasgow, U.K. (NEL) and Exxon Production Research Company (EPR) on oil rig quality (ORQ) studlink chain with bar diameters of 2 in., 3 in., and 4 in. [3, 4]. The studless fatigue curve is based on the saltwater tension-tension fatigue tests performed by NEL on R3 and R4 studless chain with a bar diameter of 3 in. [5]. All publicly available saltwater studlink and studless chain fatigue data are summarized in Table 1, and the fatigue test data are listed in Annex A.

Table 1—Summary of Saltwater Chain Fatigue Failure Data

Chain Fatigue Failure Data	Diameter (in.)	Slope			Censoring			
		m	−95 %	+95 %	% Failed	Failed	Runout	Tested
ORQ Studlink, NEL	3 and 4	−2.588	−2.802	−2.374	50	20	20	40
ORQ Studlink, EPR	2	−3.951	−4.425	−3.653	See NOTE	40	See NOTE	See NOTE
ORQ Studlink, Shell [a]	See NOTE	—	—	—	See NOTE	16	See NOTE	See NOTE
ORQ Studlink, NEL and EPR	2, 3, and 4	−3.054	−3.26	−2.848	See NOTE	60	> 20	> 80
K4 Studlink, NEL	3 and 4	−1.902	−2.212	−1.591	52	12	11	23
R3 Studless, NEL	3	−2.419	−2.613	−2.225	52	44	40	84
R4 Studless, NEL	3	−2.336	−2.574	−2.098	43	31	41	72

NOTE The diameter of the Shell chain is not known; or the percent failed, number of runout links or number of tested links were not reported.

[a] The Shell tests were all performed at the same tension range, consequently they contain no information on the slope (m) of the fatigue curve.

2 TN and SN Mooring Component Fatigue Curves

API's component TN curves are specified in terms of the non-dimensional tension range (T), which is calculated by dividing the dimensional double amplitude tension range by a reference breaking strength. For studlink chain, API specifies the reference break strength as the catalog break strength (CBS) of ORQ chain of the same size (reduced by a corrosion allowance). API's fatigue curve is expressed as shown in Equation (1).

$$\log_{10}(N) = m\log_{10}(T) + \log_{10}(a) \tag{1}$$

where

T is the tension range/CBS of ORQ;

m is the slope of fatigue curve;

$\log_{10}(a_S)$ is the intercept of fatigue curve;

N is the number of cycles.