Fatigue Performance of Machined Pipe Outer Surface

Ph. P. Darcis¹, I. Marines-Garcia¹, L. Di Vito², E. C. Marques¹, N. D. Dell’Erba¹, F. Tintori³, M. Armengol³ and H. M. Quintanilla¹

¹. TenarisTamsa R&D, TenarisTamsa, Veracruz, Mexico
². Structural Intergrity, Centro Sviluppo Materiali SpA, Roma, Italy
³. Product Engineering Pipelines, TenarisDalmine, Dalmine (BG), Italy

ABSTRACT

The present work proposes to evaluate the actual roughness impact of machined pipe body outer surfaces on fatigue performance. For this aim, a testing program has been defined comparing the fatigue performance of machined surfaces on high-strength steel pipes. Eight full scale fatigue tests have been performed with two different outer surface roughness targets. No appreciable difference in fatigue behavior has been observed between the different targeted surface statuses, showing that machined surfaces on these high grade steels results to be suitable for fatigue applications even with higher roughness values.

KEY WORDS: Fatigue; seamless pipe; surface machining; roughness.

NOMENCLATURE

\( n \) Number of fatigue tests for the qualification
\( N \) Number of cycles to failure
\( N_t \) Target number of cycles
\( OD \) Outside pipe Diameter
\( R \) Loading ratio
\( Ra \) Roughness average value
\( RMS \) Roughness Measurement System
\( Ry \) Roughness maximal value
\( S \) Stress range
\( sd \) Standard deviation
\( SMLS \) Seamless
\( WT \) Wall Thickness
\( \sigma \) Standard deviation

INTRODUCTION

The possibility to manufacture heavy and ultra-heavy wall seamless pipes opens new perspectives to machine pipe body outer surfaces for the production of rigid riser’s connections (i.e. upsets, flanges, connections, J-lay collars …). This option allows to avoid costly forged pieces and allows to guaranty a better manufacturing quality. From this perspective, a question to be faced is the definition of the OD manufacture quality requirement, which directly impacts the pipe manufacture productivity and, consequently, the product cost. On the other hand, among the products that could be subjected to surface machining there are pipes destined to fatigue loading during service. As a consequence, concerns arise about the fatigue resistance of machined pipes.

In this framework, the present paper proposes to evaluate the actual roughness impact of machined pipe body outer surfaces on fatigue performance. For this aim, a testing program has been defined comparing the fatigue performance of machined surfaces on steel pipes of grade Q125 and TN125 (the TN125 is similar to Q125 grade with a different chemistry).

Eight full scale fatigue tests have been performed. Seven pipes have been machined with two different providers and one pipe was tested as manufacture (grade TN125). The first provider manufactured specimens using pipe on steel grade Q125 and the second one using pipe on steel grade TN125. Two different outer surface roughness targets were defined: \( Ra \) 125 and 500 RMS.

MATERIAL FOR THE TESTING PROGRAM

In the framework of this study, two different materials have been used to machine the pipes external surface, OD. Even if Tenaris has accumulated an extensive metallurgical experience from manufacturing SMLS pipes, the first objective of the present work was not to develop a specific alloy design. Thus two different grades, Q125 and TN125 issued of our actual stocks, were used to perform this research work. The two materials will be considered indifferent for present investigation, since no particular influence of the effect of the material