COMPARISON OF SELECTED FATIGUE CHARACTERISTICS OF P92 STEEL AND 15CH2NMFA STEEL

VOLÁK Josef[1], BUNDA Zbyněk[1]

[1]*University of West Bohemia, Regional Technological Institute, Pilsen, Czech Republic, EU,*
volak@rti.zcu.cz

Abstract

The paper deals with use of small samples for fatigue tests. The main advantage of the small fatigue samples is in use in cases, where sufficient amount of material is not available. For example at power plant parts. Results of small sample tests are afterwards correlated with the results of standard fatigue test specimens. Further different ways of sample manufacturing are compared. The small samples are produced either by machining, or cutting with waterjet. The stress concentration of the small fatigue sample is detected using finite element method.

Keywords: Small fatigue test, concentration of stress, P92, 15CH2NMFA, waterjet

1. INTRODUCTION

In this paper the results of the fatigue tests using two types of samples are compared. The results of the standard fatigue samples from steel P92 were compared with results of the Small Fatigue Test samples from steel P92 (SFT) produced using 1st machining and also using 2nd water jet. The standard fatigue samples from steel 15CH2NMFA were compared with SFT from this material.

In the present a great interest is given to the Small Punch Test method. Its biggest advantage is almost non-destructive intervention in the integrity of structures thanks to the small amount of removed material which could be advantageous also for production of SFT samples. This "new" (also called) semi-destructive method allows to evaluate the current status of operating components on small samples which do not disrupt the integrity of the operating components and it enables to evaluate the current status without long outages. To produce fatigue samples, we used the same shape according to [1] (**Figure 1**). We began using the name SFT (Small Fatigue Test) for the miniaturized fatigue specimens.

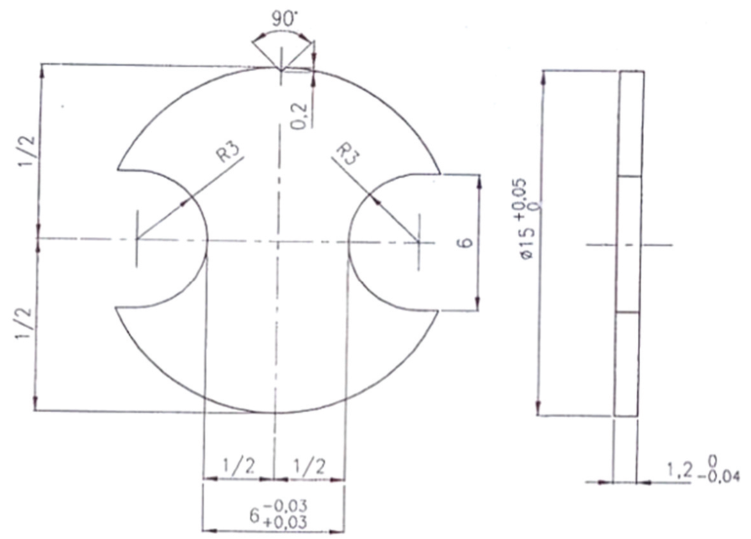

Figure 1 Shape of Small Fatigue Test samples [2]

2. SAMPLES PRODUCTION

Traditional specimens for fatigue tests were made according to standards (**Figure 2**). SFT samples were made by traditional methods of machining (turning, milling). First, it was made 15 mm diameter shaft, then milled on both sides of the radius (**Figure 3**), then the samples were cut to approximately 1.3 to 1.5 mm and finally grinded. Another set of samples was cut by water jet (**Figure 4**). First, the sample was about 290 mm length, 60 mm width, 8 mm thick milling and then grinding by the plane grinder to the final 1.2 mm. The objective was to compare the results of conventional fatigue tests with small samples and compare the influence of SFT production types on the results of fatigue tests.

Figure 2 Standard testing samples

Figure 3 SFT samples

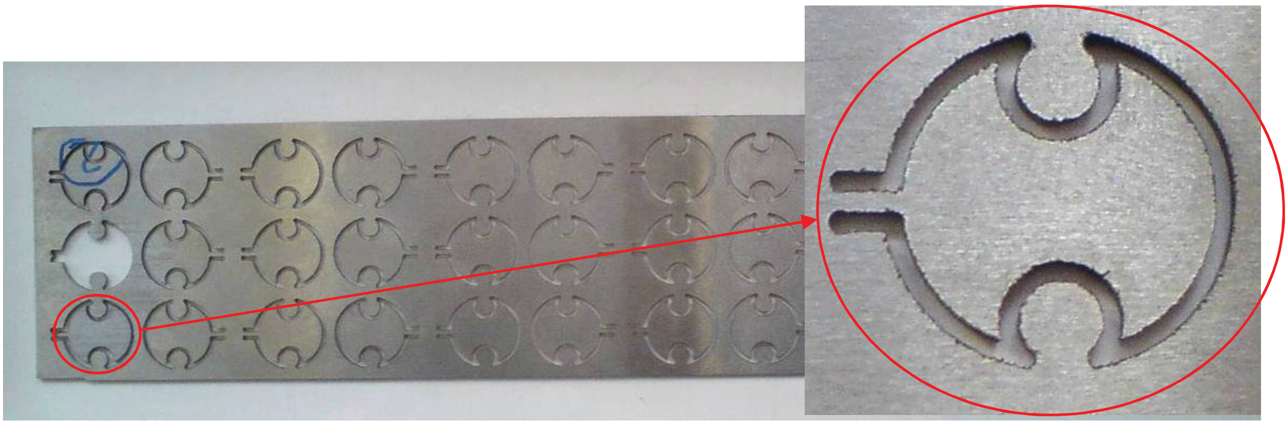

Figure 4 Samples cut by the water jet

3. FATIGUE TEST PERFORMANCE

Amsler 10 HFP 5100 (high-frequency pulsator) ZWICK//Roell machine was used for the realization of fatigue experiments. To fit standard round specimens, accessories of the machine were used and threads were adapted to the possibilities of this device (**Figure 5**). To fit the SFT fatigue samples, special grips have been previously made (**Figure 6**).

Figure 5 Testing machine Amsler 10 HFP 5100. Detail of the standard specimen fitting (left)

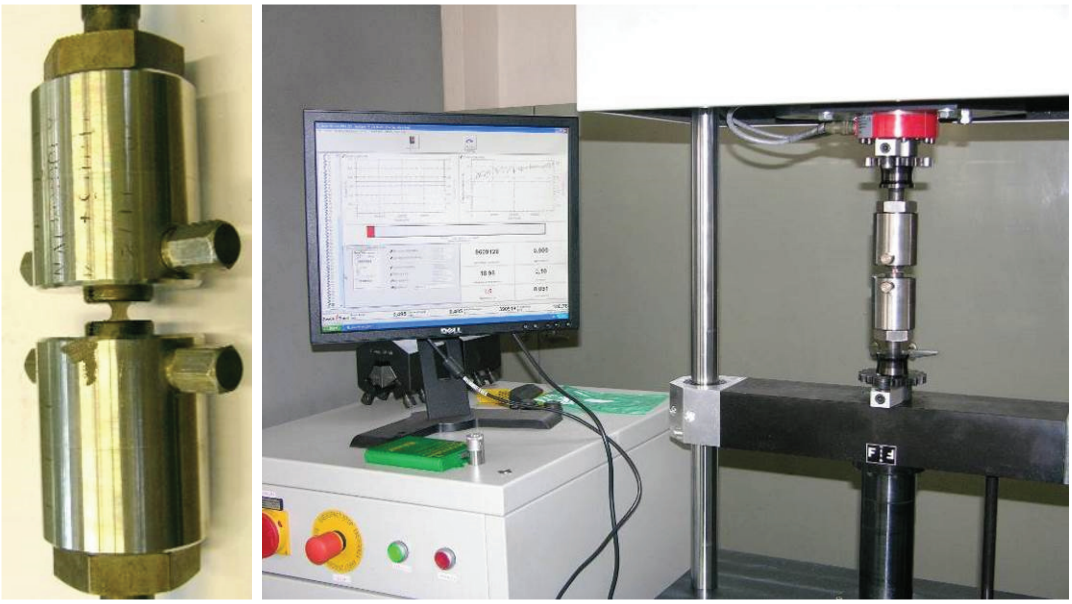

Figure 6 Principle of fitting SFT specimens (special grips)

4. EXAMINATION PROCESS

Tests were performed as a cyclic loading with force control, the frequency of the material (f = 120 Hz to 145 Hz) with a cycle asymmetry (R = 0.1). Termination of fatigue limit was set at 10^7 cycles which corresponds to the fatigue of steel materials. The tests were performed on standard and SFT fatigue samples. Test results are summarized in **Figures 7 - 9**.

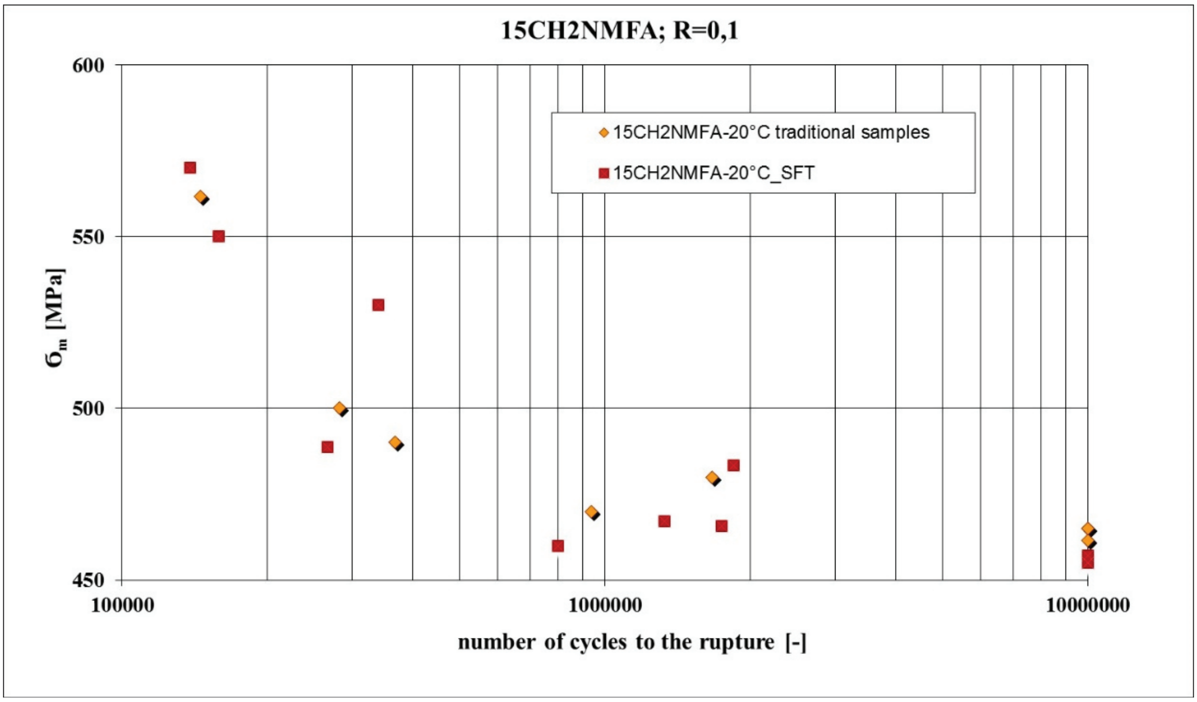

Figure 7 Comparing results of traditional samples and SFT samples from steel 15CH2NMFA, cycle asymmetry R = 0.1

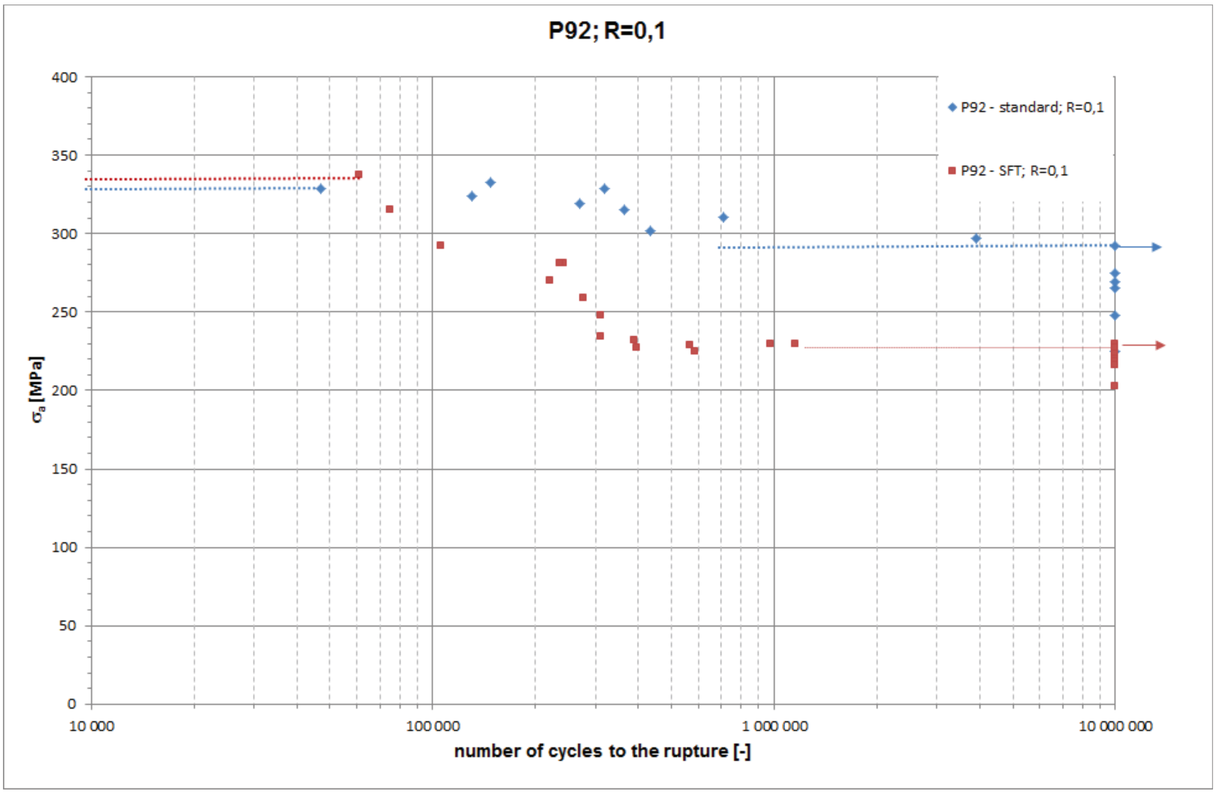

Figure 8 Comparing results of traditional and SFT fatigue samples from steel P92, cycle asymmetry R = 0.1

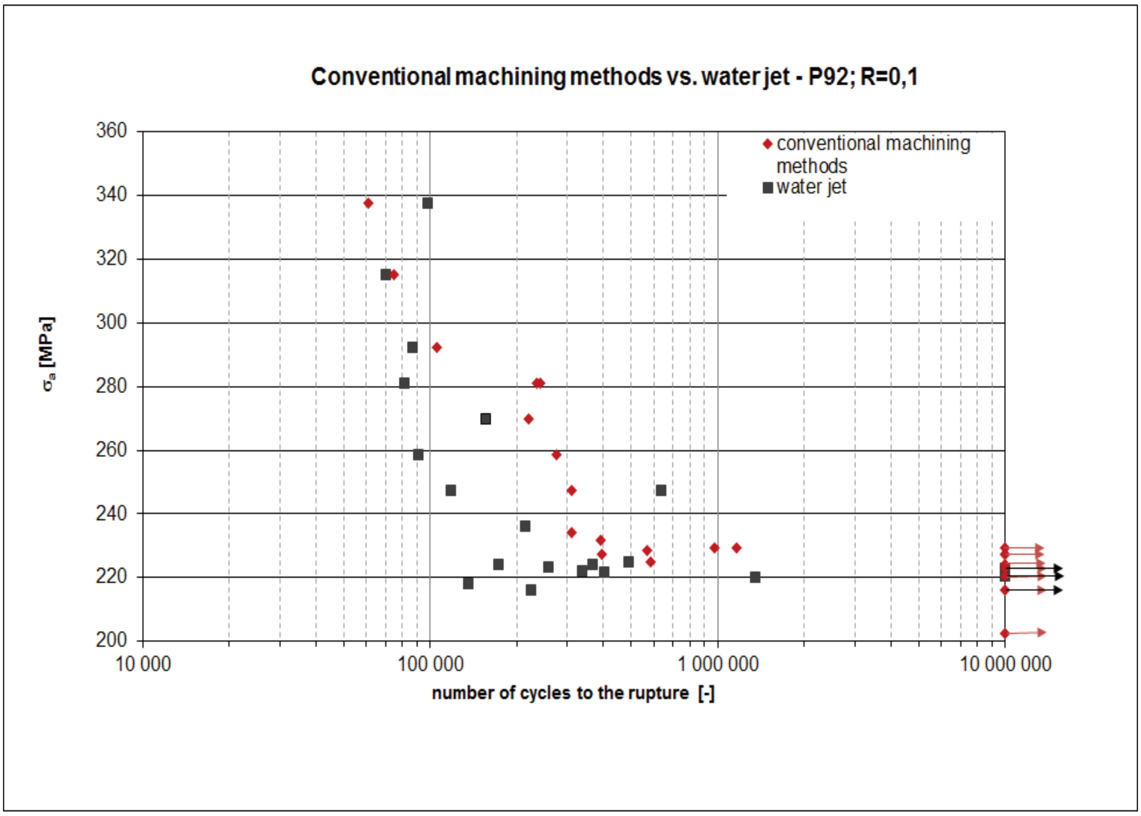

Figure 9 Comparing results of SFT fatigue samples from steel P92, cycle asymmetry R = 0.1

5. CONCLUSION

In case of samples from steel 15CH2NMFA (**Figure 7**) and stress concentration 1.33, the results of traditional fatigue test samples and SFT samples are similar. Also results of fatigue limit were identical.

When considering the stress concentration 1.33 at SFT samples neck (this concentration is already included in **Figure 8**), the results are shifted in both low cycle and high cycle fatigue lower than the results of conventional tests [2]. This is the material property, e.g. for aluminium alloys the fatigue results were almost identical when considering stress concentration for SFT specimens and nominal stress for standard specimens.

The results of steel 15CH2NMFA and of steel P92 vary after reasoning stress concentration. That is why we decided to try to test new shape of samples (**Figure 10**), which are not influenced by stress concentration [3]. The fatigue behaviour at these new-shaped samples is assumed similar as standard samples without considering stress concentration.

Figure 10 New type of samples will be tested

Despite the dispersion of results (especially in low-cycle fatigue) the evaluated fatigue limits vary by less than 5 MPa and impact of the tested production types in the standard way or by water jet to determine the fatigue limit is thus negligible (**Figure 9**).

ACKNOWLEDGEMENTS

The present contribution has been prepared under project LO1502 'Development of the Regional Technological Institute'under the auspices of the National Sustainability Programme I of the Ministry of Education of the Czech Republic aimed to support research, experimental development and innovation.

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