

Accepted Manuscript

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PII: S0142-1123(16)30140-2

DOI: <http://dx.doi.org/10.1016/j.ijfatigue.2016.05.032>

Reference: JIJF 3981

To appear in: *International Journal of Fatigue*

Received Date: 14 February 2016

Revised Date: 25 May 2016

Accepted Date: 26 May 2016

Please cite this article as: Jiang, Q., Sun, C., Liu, X., Hong, Y., Very-High-Cycle Fatigue Behavior of a Structural Steel with and without Induced Surface Defects, *International Journal of Fatigue* (2016), doi: <http://dx.doi.org/10.1016/j.ijfatigue.2016.05.032>

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Very-High-Cycle Fatigue Behavior of a Structural Steel with and without Induced Surface Defects

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Abstract: Fatigue tests via rotary bending were performed on the specimens with and without induced surface defects for a structural steel of medium carbon content to investigate the effect of surface defects on fatigue behavior in high-cycle fatigue and very-high-cycle fatigue (VHCF) regimes. The S-N data showed that induced surface defects substantially degraded the related fatigue strength. For the specimens without surface defects failed in VHCF regime, crack initiated from the interior of specimens with inclusions or matrix inhomogeneities as crack origin and the initiation regions were of different extents of rough surface. The observations on the profile samples cut from crack initiation regions revealed that the region was a layer of nanograins for the case of inclusion as crack origin, and was without grain refinement for the case of grain boundary as crack origin. For the specimens with induced surface defects, crack initiated from surface defects and the initiation region was without grain refinement. The characteristics of crack initiation were carefully examined and the effect of surface defects on fatigue strength degradation was analyzed by available models.

Keywords: Very-high-cycle fatigue; Surface defect; Fine-granular-area; Crack initiation; Structural steel

1. Introduction

Since the work of Naito et al. [1], very-high-cycle fatigue (VHCF) behavior has received increasing attentions in fatigue research community [2-8]. For high-strength

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