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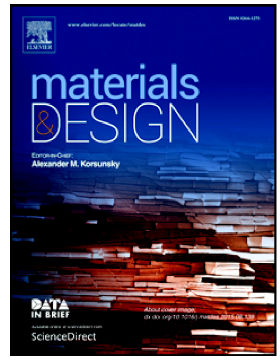

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Mapping of Axial Plastic Zone for Roller Bearing Overloads using Neutron Transmission Imaging

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Abstract: *Premature failure of wind turbine gearbox bearings is an ongoing concern for industry, with sudden overload events potentially contributing towards raceway damage, significantly hindering performance. Subsurface stresses generated along a line contact cause material yielding, and a probable crack initiation site. Currently, the ability to study subsurface plastic zone evolution using non-destructive techniques is limited. Neutron Bragg edge imaging is a novel technique, allowing for two-dimensional mapping of the Bragg edge broadening parameter, indicative of bulk plastic deformation. An experiment on the ENGIN-X strain scanning instrument, at the ISIS neutron source, UK, was setup for Bragg edge transmission imaging, to measure the effect of in situ loading on the raceway of a bearing, scaled-down from a traditional wind turbine gearbox bearing. Results demonstrate a strong correlation between load and the Bragg edge width, and allow for future experimental development in studying, not only the effect of overloads on fatigue life, but also the use of neutron imaging for evaluating plastic deformation in engineering components.*

Keywords: time-of-flight; energy-dispersive imaging; Bragg edge imaging; neutron radiography; bearing overload; subsurface plasticity.

1. Introduction

Wind turbine gearbox bearings, even after decades of engineering optimisation, are still considered to be the root-cause of many failures. Even with the presence of ISO gearbox design standards and specifications [1], bearings continue to fail significantly prematurely, when compared to their design lifetimes [2]. Within the UK, 35.1% of claims processed from wind turbine operators were due to the deterioration of the gearbox [3]. The detrimental impact on installation and operating costs of wind turbines has directed research attention towards further understanding the causes of failure.

Cylindrical roller bearings, such as those found in a wind turbine gearbox, are generally designed to withstand heavy radial loads at moderate rotational speeds [4], [5]. Whilst there are various roller