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Faeez Masurkar
The British University in Dubai, Dubai, UAE

Application of Optical Laser System for Health Monitoring of Engineering structures

Abstract: This keynote is about the application of laser-based optical systems induced ultrasonic guided waves to interrogate the health condition of Engineering structures. A point like excitation from laser system could induce wideband frequency response ultrasonic waves into the inspected structures which could hinder an appropriate interpretation of the recorded wave propagation data. Thus, this talk covers the development of an optical system which can create custom designed shapes and sizes of arrayed pattern that can facilitate the impingement of desired narrowband excitation frequency of ultrasonic waves to be generated within the structure. The present talk shall cover the use of this system to be employed on Rail track sturture and also will discuss other potential engineering applications. For the rail track, a line-arrayed pattern is developed through the optical system that generates narrowband Rayleigh waves with high power on the surface of the rail. As a result of lattice-anharmonicity, a second harmonic is produced in the wave that is sensed by a scanning laser Doppler vibrometer. The spectral amplitudes of the first and generated second harmonics are used to calculate the inherent nonlinearity using an amplitude-based nonlinearity equation. The experimentally evaluated nonlinearity of the rail steel is further compared with that obtained using a physics-based nonlinearity equation that relies on the higher-order elastic constants. Agreement of the results shows that optical system is effective in generating Rayleigh waves in rails and thereby measuring the inherent nonlinearity of the rail track. The estimation of inherent nonlinearity may help in diagnosing the health status of the macroscopically intact rail specimens in terms of their microstructural consistency and level of dissolved impurities before fixing them on a track.

Keywords: Optical system, Laser, Health monitoring, Engineering structures, Ultrasound

Biography: Dr. Faeez is an Assistant Professor of Mechanical Engineering at the British University in Dubai. In the past, he worked as an Assistant Professor of Mechanical Engineering and workshop superintendent at ViMEET, a University of Mumbai affiliated Institute. He then moved to Belgium in 2016 to work as a research staff member at Ghent University. In Oct 2020, after receiving his Ph.D. degree from the City University of Hong Kong he moved to Arizona State University to continue his postdoctoral studies where he worked on numerous projects funded by NASA, Boeing, and Northrop Grumman. Before Joining British University, he worked at A*STAR research Entities in Singapore as a Scientist. He has extensive research experience in Non-destructive testing and Structural Health Monitoring using ultrasonic waves, Vibration, laser diagnostics, and material science.

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