Rail stress measurement using Optical fluorescence spectroscopy technology

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In modern railway track systems, continuous welded rails (CWR) are used to enable high-speed travel and improve maintenance efficiency. Continuously welded rails experience axial stress along their length as a result of temperature fluctuations stemming from their uninterrupted nature over long distances. It is crucial to effectively control these stresses in rails. However, it is not possible to apply the method of measuring strain and converting it into stress, as is commonly done in other situations, because continuously welded rails are constrained by fasteners and sleepers, creating an immovable zone where no axial deformation can occur due to the stress. Various technologies have been developed to overcome these issues and measure axial stress. These technologies can be categorized into destructive and non-destructive methods. Destructive methods include rail cutting, hole drilling, lifting, and other techniques that introduce deformation to the rail and observe its response based on the existing stress conditions. Non-destructive methods have the advantage of measuring the rail's existing state without introducing any deformation. Examples of these methods include ultrasonic techniques, eddy current techniques, electromagnetic methods, and optical methods. While each of these techniques has its own advantages, there are various limitations in accurately measuring rail stress in railway field. As a result, additional research efforts are underway to address these limitations. Among these, optical methods for measuring rail stress include technologies that use X-rays and the Photo-luminescence piezo-spectroscopy (PLPS) technique. In this study, we have developed fluorescence spectroscopy system designed for railway field by implementing technologies aimed at addressing these improvements.