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Feature Article: SQUID Applications
- Non-destructive SQUID-Based Testing for Railway Applications

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A friction between a rail and wheels during acceleration and braking can lead to the formation of a thermally-transformed hard but fragile structure on the surface of the rail, a so-called white etching layer (WEL). The area around the WEL triggers the formation of micro-cracks that expand easily leading to rail damage by the delamination on the surface of the rail. WEL is considered one of the causes of rail damage and investigations to better understand the relationships are being actively pursued.

In this study, the author and his research group have confirmed that the SQUID-eddy current technique can be employed to investigate the formation of WEL on the rails. Our initial system, however, demagnetized the specimen in advance and was completely magnetically shielded in order to eliminate the remanent magnetism of the rail.

Having a system that is magnetically shielded completely is not feasible for rail field measurements. A prior process to demagnetize the rail is also undesirable because of increased detection times. To overcome this, a prototype rail testing system comprising a SQUID has been specifically designed for field tests, as shown in Figure 1. Figure 2 shows the measurement principle. The only detection probe, comprising of a bridge circuit, is placed closer to the rail allowing the SQUID to obtain signals from the input coil. Also, this allows for the SQUID to be completely housed in a magnetic shield enclosure and placed several distance from the rail. The prototype system performs consistent measurements that eliminate the influence of the remanent magnetism of the rail.

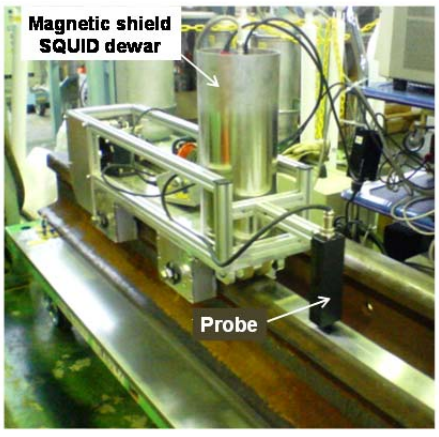

Fig. 1 SQUID-rail testing system

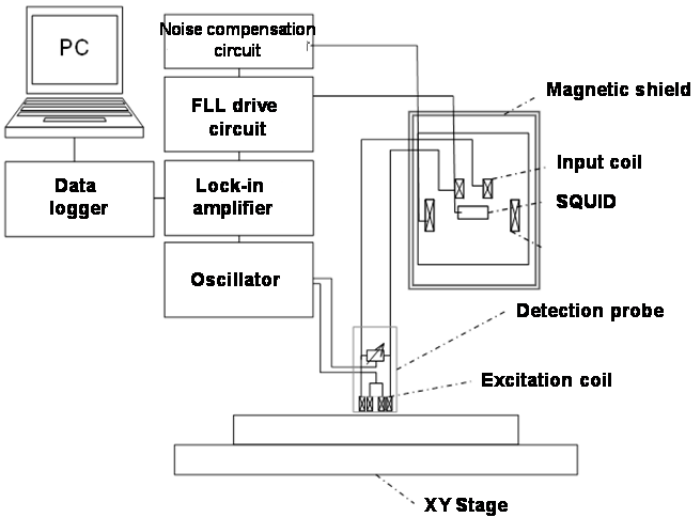

Fig. 2 The principle of SQUID-rail testing

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The measurement system specifically designed for outdoor use was installed and tested on a rail scanning system, performing measurements of an actual WEL. At a scanning speed of 5mm/sec, a WEL with an approximate thickness of 15μm was successfully detected. The system validated the prospect of determining WEL formation using a SQUID (Figure 3).

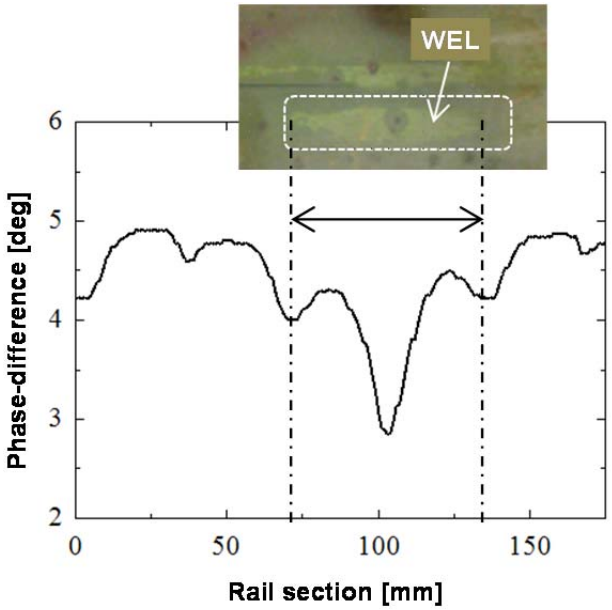

Fig. 3 The detection results measured at a scanning speed of 5mm/sec

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