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Improved train safety through improved locomotive braking performance – public report

by

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Executive summary

The safe operation of the cane railway, in the same way as for mainline railways, is gaining greater attention. One important aspect of safe operation is the ability to stop a train in an acceptable distance (or time). Previous work has measured quite variable braking performance (and hence stopping distance) in an extensive series of tests with different locomotives on different track sections in different mill areas. It was found that the locomotive driver was the most variable factor associated with braking performance. When the driver factor was eliminated through the application of a fixed braking pressure, very consistent braking performance could be achieved. It was concluded that it was the driver's ability to detect wheel slide and their action to reduce slide that caused the variability in braking performance. It was hypothesised that an anti-lock braking system (ABS), where the driver has little influence on the braking performance, could deliver better average braking performance and hence reduced, or at least more consistent, stopping distances.

This project aimed to compare the braking performance of an anti-lock braking system to the performance of manual braking in terms of the magnitude and variability of stopping distance. A first series of tests was conducted in the middle of 2007 using only a locomotive and concluded that the anti-lock braking system performed as well as an experienced driver in a slide situation and appeared to give better on average braking in a no slide situation. The results suggested that the use of anti-lock braking systems allows maximum average brake pressure to be applied without the "feel" of an experienced driver.

Further braking tests were carried out in 2007 and 2008 using a train made up of a locomotive and a rake of bins. Tests were carried out under a range of conditions at two mills, Invicta (with Willison couplings) and Proserpine (with link and pin couplings). The results showed that anti-lock braking achieved similar average coefficients of adhesion to manual braking. There was no conclusive evidence that ABS braking is better than manual braking. It was noted that these tests were carried out by experienced drivers who were paying attention to braking performance.

An anti-lock braking system is expected to provide a coefficient of adhesion equivalent to that achieved by an experienced driver. This performance will be of benefit in situations where the train is being driven by an inexperienced driver or in an emergency situation where the driver might be greatly distracted.

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1. Background

The safe operation of the cane railway, in the same way as for mainline railways, is gaining greater attention. One important aspect of safe operation is the ability to stop a train in an acceptable distance (or time). Previous work found that the locomotive driver was the most variable factor associated with braking performance. When the driver factor was eliminated through the application of a fixed braking pressure, very consistent braking performance could be achieved. It was found that it was the driver's ability to detect wheel slide and their action to reduce slide that caused the variability in braking performance. An anti-lock braking system (ABS), where the driver has little influence on the braking performance in a potential slide situation, could deliver better average braking performance and hence reduced, or at least more consistent, stopping distances. With more consistent braking performance, load and speed limits can be set for locomotives with a greater degree of certainty over the resulting performance.

2. Objective

- To investigate the hypothesis that anti-lock braking systems on locomotives can reduce train stopping distance and hence improve train safety and the safety of the local community.
- To develop a specification for an anti-lock braking system for a canefield locomotive.

Both project objectives were met.

Four experiments were conducted to investigate the hypothesis that anti-lock braking systems on locomotives can reduce train stopping distance. The results showed that there was no statistically significant difference in the stopping distance achieved by an anti-lock braking system and an experienced driver. It was concluded that performance at the levels measured will be of benefit in situations where the train is being driven by an inexperienced driver or in an emergency situation where the driver might be greatly distracted.

A survey showed that approximately 10% of the industry's locomotives had anti-lock braking systems at the start of this project. Two of those systems were studied during this project and further development of one system was undertaken as part of the project. A specification for this system has been developed.

3. Methodology

The comparison of anti-lock braking systems to manual driver braking involved four braking experiments. In each experiment, the braking performance of the locomotive was measured under manual braking conditions and under anti-lock braking conditions.

The first experiment involved using one 39 tonne locomotive at Invicta Mill which had an anti-lock braking system already installed. The experiment was carried out in the middle of 2007 using only the locomotive (no cane bins).

Three further experiments involved comparing manual braking to ABS braking using a train made up of a locomotive and a rake of bins. The second and third experiments were carried out at Invicta Mill in late 2007 and in 2008 respectively, using a locomotive and a rake of cane bins attached by Willison couplings. The fourth experiment was carried out in 2008 at Proserpine Mill using a 40 tonne locomotive and a rake of cane bins attached by link and pin couplings.

4. Results

The first experiment, conducted using a locomotive only, concluded that the anti-lock braking system performed as well as an experienced driver in a slide situation and appeared to give better on average braking in a no slide situation. The results suggested that the use of anti-lock braking systems allows maximum average brake pressure to be applied without the “feel” of an experienced driver.

From the 2007 and 2008 Invicta Mill test results and the 2008 Proserpine Mill test results, there was no conclusive evidence that ABS is better than manual brake control. The results showed that anti-lock braking achieved similar average coefficients of adhesion to manual braking when the train was being operated by an experienced driver. Therefore an anti-lock braking system is expected to provide a coefficient of adhesion equivalent to that achieved by an experienced driver. This performance will be of benefit in situations where the train is being driven by an inexperienced driver or in an emergency situation where the driver might be greatly distracted.

5. Expected outcomes

It is expected that the members of the project syndicate will perceive a benefit in increased safety in cane train operation through the installation of an anti-lock braking system in locomotives. That perceived benefit is expected to result in installations of the system in existing locomotives and/or the specification of such a system in new locomotive acquisitions. Better average braking performance and hence reduced, or at least more consistent, train stopping distances should be the result. With more consistent braking

performance, load and speed limits can be set for locomotives with a greater degree of certainty over the resulting performance.