Legislative Council Panel on Transport
Subcommittee on Matters Relating to Railways

Recent Railway Incidents involving MTR Rail Cracks

Purpose

At the special meeting of the Subcommittee on Matters Relating to Railways under the Legislative Council Panel on Transport held on 21 February 2011 when "Recent Railway Incidents involving Rail Cracks" was discussed, MTR Corporation Limited (MTRCL) had provided information on 14 rail breakages identified in the MTR network between 1 January 2008 and 10 February 2011, including one in the Light Rail network and one in the Hung Hom Freight Yard where no passenger-carrying operation is involved. Among the 14 cases, the root causes for 11 cases have been identified and reported in the paper submitted to the Subcommittee (LC Paper No. CB(1) 1323/10-11(03)). This paper provides Members with the results of the investigations into the causes of the remaining three cases and the corresponding improvement actions.

Technical Investigations

East Rail Line rail breakage case on 13 January 2011

2. Increased stress concentration is determined to be the root cause of the rail breakage found at an insulated rail joint section on the East Rail Line north of Fo Tan Station on 13 January 2011. An insulated rail joint is where two long sections of rail are mechanically joined together and secured by plastic-coated steel plates and steel bolts. The rails are electrically insulated from each other.

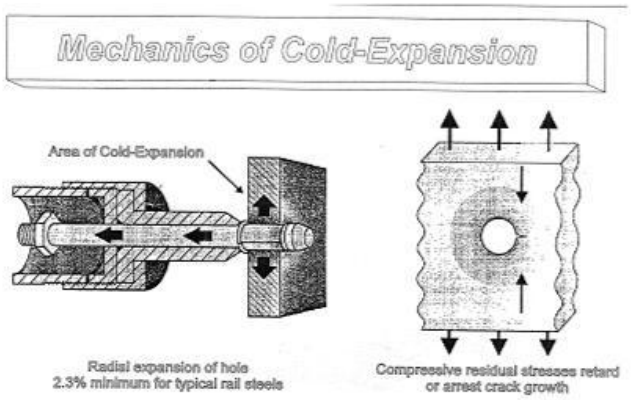
3. Results of the investigation and laboratory analysis show that one of the steel plate fastening bolts was found broken nine days earlier and was replaced. In common rail maintenance practice in railways around the world, a bolt of the same size would be fitted. However, under normal operational environment, the bolt holes in the rail and the steel plates may have shifted slightly and not be perfectly aligned. If the same size bolt can then not be inserted, a temporary bolt of a smaller diameter would be used, so was the situation in this case. The temporary bolt and the insulated rail joint section were then scheduled to be removed and replaced after the end of passenger service on 23 January 2011.

4. Increased stress concentration was introduced with the smaller diameter bolt in place, causing additional flexing when trains passed over the insulated rail joint. This caused a crack to develop from inside the adjacent bolt hole and ultimately breakage of the rail.

5. The chemical composition of the rail was found to be within specification.

6. The improvement actions taken / to be taken are set out below –

Improvement actions	Status
<u>Replacement of insulated rail joint</u> The affected insulated rail joint was replaced after the close of train service on the day	• Completed on 14 January 2011
<u>System-wide check of insulated rail joints</u> A system-wide check of insulated rail joints has been conducted. Seven other insulated rail joints on the East Rail Line and one on the Island Line were identified to be fitted with temporary bolts that were smaller in diameter. No cracks were found in the rails. The temporary bolts have all been replaced with standard bolts that will not induce added stress on the bolt holes.	• Completed on 11 March 2011
The rail sections of the eight insulated rail joints will be closely monitored with special attention paid during regular patrols until the rails are replaced.	• Concerned insulated rail joints to be replaced by end April 2011
<u>Enhanced instructions</u> An instruction has been issued to maintenance staff specifying that temporary bolts should be replaced with a standard size bolt within 7 days.	• Completed on 11 March 2011

Improvement actions	Status
<u>Introduction of cold expansion technology</u> The advanced technology of cold expansion of bolt holes is to be introduced on the East Rail, West Rail and Ma On Shan Lines as well as the Light Rail network for the drilling of all bolt holes. The technology was introduced for use on the pre-merger MTR lines. It develops ring stresses around bolt holes to reduce the probability of crack formation in holes that have to withstand repeated stress.	• Equipment was ordered in November 2010 prior to the recent rail breakage incidents for application of cold expansion to new site-made bolt holes on the East Rail, West Rail and Ma On Shan Lines. • Implementation by June 2011 

<u>Tung Chung Line rail breakage case on 19 January 2011</u>

7. High stress concentration is determined to be the root cause of the rail breakage found near Sunny Bay Station on the Tung Chung Line on 19 January 2011.

8. Investigation and laboratory analysis concluded that a steel cable protection pipe was in contact with the underside of the rail. As rails serve as a conductor for electrical current, there was intermittent electrical discharge which led to arcing. Heat generated from the arcing caused local melting of the pipe and underside of the rail at the point of contact. This resulted in high stress concentration in the area, causing a crack to start forming on the underside of the rail and subsequent breakage.

9. The chemical composition of the rail was within specification.

10. The improvement actions taken are set out below –

Improvement actions	Status
<u>Replacement of rail section</u> The affected rail section was replaced after the close of train service on the day.	• Completed on 20 January 2011

System-wide check A system-wide check of all tracks to identify locations where steel or metal pipes crossed under rail sections was conducted. No further location was identified.	• Completed on 24 January 2011
Lowering of steel pipe The position of the steel pipe was immediately lowered to eliminate contact with the new rail section.	• Completed on 20 January 2011
Replacement of the steel pipe The steel pipe was replaced by a plastic pipe which was maintained at the lowered position.	• Completed on 27 January 2011
Enhanced instructions An instruction has been issued specifying the minimum clearance that must be maintained between the underside of rails and a pipe crossing underneath.	• Completed on 11 March 2011

Tsuen Wan Line rail breakage case on 10 February 2011

11. High stress concentration at the rail weld is determined to be the root cause of the rail breakage found between Admiralty Station and Tsim Sha Tsui Station on the Tsuen Wan Line on 10 February 2011.

12. Investigation and laboratory analysis concluded that very high stress was put on the rail at the point of a weld which had been made on-site in 2006. The rails in the relevant tunnel section are continuously supported by rubber padding. As the cross-section of welds are slightly larger than that of the rails, the underside of welds are compressed more into the rubber padding when trains pass over. The concerned weld was located on a curved section of rail and took on the heavier load of trains passing over it, creating a higher stress concentration point that developed into a crack at the bottom of the rail and which ultimately led to breakage.

13. The chemical composition of the rail was within specification.

14. The improvement actions taken are set out below –

Improvement actions	Status
Replacement of rail section The affected section of the rail was replaced after the close of the train service on the day.	• Completed on 11 February 2011
System-wide check A system-wide check of all site welds sitting on rubber padding in the system was conducted. All were found to be in normal condition.	• Completed on 20 February 2011
Cut gaps on rail pads under site welds A gap has been cut in the rubber padding under similar site welds to eliminate compressive force.	• Completed on 23 February 2011
Enhanced Instructions An instruction has been issued to maintenance staff specifying that a gap must be provided in the continuous rubber padding support under all site welds to prevent compressive force.	• Completed on 11 March 2011

Conclusion

15. While rail cracks / breakages are a phenomenon that occurs on railways throughout the world, MTRCL takes seriously every incident of a rail breakage and promptly reports them in accordance with the Mass Transit Railway Regulations. A comprehensive investigation and review is conducted into every case and improvement measures are introduced as appropriate. The number of rail breakage cases will also be made public regularly and uploaded to MTRCL's website.

16. The cause and circumstances of each of the three rail breakages in 2011 are different. Detailed investigations were conducted into each case and improvement initiatives have been or are being introduced to minimise the chance of recurrence.

17. With a commitment towards continuous improvement, MTRCL has engaged a team of experts on rail technology from the Monash University – Institute of Railway Technology ("the Institute") to conduct a comprehensive review of MTRCL's rail procurement, quality control, inspection and maintenance regime with particular focus on rail cracks and breakages. The Institute is an internationally recognised authority on railway technology and is expected to complete the review in July 2011.

18. MTRCL will continue to implement a stringent regime for inspection and maintenance of its rail asset and looks forward to receiving the Institute's recommendations for additional improvements.

MTR Corporation
March 2011