#### **For Information**

## Legislative Council Panel on Transport Subcommittee on Matters Relating to Railways

Wheel Shift Incident at the Running Maintenance Shed in the Shek Kong Stabling Sidings of the Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link

#### (I) <u>Introduction</u>

- 1. On 3 April 2018, four wheels on two bogies of the last car of an XRL train was found shifted out of position at the Running Maintenance Shed ("RMS") Track No.4 in the Shek Kong Stabling Sidings ("SSS") of the Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link ("XRL") during inspection by a staff of the MTR Corporation Ltd ("MTRCL").
- 2. After the incident, the MTRCL with the involvement of railway experts from XRL rolling stock supplier as well as an independent railway expert, conducted an in-depth investigation into the incident. On 28 May 2018, the Corporation submitted investigation results to the Government on the causes of the incident and recommended follow-up actions (see **Annex 1**).
- 3. This paper serves to brief the Subcommittee on the sequence of events, immediate actions and recovery measures undertaken, investigation findings and follow-up actions regarding the incident.

#### (II) Sequence of Events

- 4. At around 9:15pm on 3 April 2018, an MTR depot staff member detected and reported the aforesaid wheel shift situation during inspection. The management of the Corporation then notified the Electrical and Mechanical Services Railway Branch. The Corporation also proactively issued a Press Statement at around 2:15am on 4 April regarding the incident (see <u>Annex 2</u>).
- 5. The incident site was immediately cordoned off to facilitate investigation and recovery actions by the MTR Rapid Response Units and in-house experts. Experts from the train manufacturer, CRRC Qingdao Sifang ("Sifang") and an independent railway expert from the Monash University Institute of Railway Technology ("IRT") arrived on the following day (i.e. 4 April 2018) to assist in the investigation.
- 6. To play safe, the Corporation temporarily suspended the trial running of XRL trains and the use of RMS Track No.4 immediately after the incident. A media standup was conducted and another Press Statement (see <u>Annex 3</u>) was issued in the late afternoon on 4 April 2018 to provide more information on the incident.
- 7. After records have been taken, the concerned wheels of the last car of the incident train were re-positioned and shunted towards the northern end of RMS Track No.4 on 5 April 2018.
- 8. The detailed sequence of events is available on page 10-11 of the investigation results at **Annex 1**.

#### (III) <u>Initial Investigation and Resumption of Trial Running of XRL Trains</u>

9. According to the findings from the investigation (see **Annex 1**), track

gauges of 1,436mm to 1,525mm (exceeding the standard dimension of 1,435mm with +8mm/-6mm tolerance) was found at the incident track location on the elevated track support section of RMS Track No.4, which explained how the four wheels of the last car of the incident train had shifted out of position. The location of the wheel drop point on the right-hand side rail at 1.65m from the tangent to the 180m radius curve was identified.

- 10. Experts from Sifang inspected the incident train and confirmed that there was no anomaly except slight damages to the car body and the two concerned bogies of the last car of the incident train, which was caused by the wheel shift incident. The incident train conformed to the operational requirements of XRL.
- 11. A special track inspection was conducted on the RMS Track No.1 to No.3, which confirmed that the track gauge is within standard dimension. While RMS Track No.4 has a short curved section of track on top of I-beam supporting structure, RMS Track No.1 to No.3 are all straight alignments. Detailed structural analysis was conducted on RMS Track No.1 to No.3 by the Detailed Design Consultant ("the Consultant") who was responsible for the design of the I-beam and supporting structure assembly below the rail in SSS. The Consultant confirmed that the supporting structure assembly can cater for the actual loading of XRL trains on these three tracks.
- 12. The independent railway expert from IRT conducted site investigation. The expert is of the view that the incident had occurred in a site-specific situation that is unique to RMS Track No.4 at SSS, which has a short (6.6m) curved section of track on top of I-beam supporting structure assembly.
- 13. With the conclusion that the incident has no correlation with trial running of XRL trains on the mainline, the Corporation obtained no objection from the relevant Government departments to resume trial running of XRL trains starting from 13 April 2018 except that RMS Track No.4 would continue to be

suspended for use until further notice. On the same day, a third Press Statement was issued to provide an update to the public (see <u>Annex 4</u>).

#### (IV) Cause of the Incident

- 14. On site evidence also indicated that the I-beams supporting the running rails at this section had been displaced and were slightly deformed.
- 15. RMS Track No.4 has a total length of 435m, out of which there is a 6.6m long curved section with radius 180m at the incident location. Both the Corporation's investigation panel and IRT are of the view that relatively high lateral forces have been exerted on the I-beam assembly structure supporting the track form, even though trains pass through the concerned section at a very low speed of less than 8 kilometres per hour.
- 16. The investigation panel has interviewed the Consultant and it was identified that the consultant had assumed lateral forces imposed on the short curved section of RMS Track No.4 would be insignificantly small and therefore adopted the same design for the I-beam assembly structure for all of the four maintenance tracks at RMS. It is now evident that the actual lateral forces exerted by the train wheels at RMS Track No.4 have exceeded the original design assumptions used, which is considered to be the root cause of this incident.

#### (V) <u>Improvement Measures</u>

17. To prevent recurrence, the Corporation is working on an improvement measure to strengthen this curved section of RMS Track No.4. It is proposed to enhance the track support assembly at the curved section by replacing the section of I beams and vertical supports with two reinforced concrete walls

under the rails. With this enhancement, the structure can withstand the actual

lateral forces while still allowing maintenance works to be carried out

underneath the train.

(VI) Conclusion

18. Both the Corporation and the independent expert from IRT concluded that

this is a site-specific incident attributable to the unique track configuration at

RMS Track No.4 located at SSS. There is no similar elevated curved section

anywhere else in XRL.

19. Post-incident investigation and thorough review of the as-built conditions

of the mainline tracks and other RMS tracks confirmed that the concerned

conditions leading to this incident do not exist anywhere else in XRL. The

overall design and construction of the mainline are in accordance with

established international high-speed rail standards.

20. Formal submission of the improvement measures will be submitted to the

Government for review before implementation. Trial operations will continue

with the objective of achieving the target of timely opening of the Express Rail

Link this September.

**MTR Corporation Limited** 

May 2018

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# **Investigation Results on**

Shek Kong Stabling Sidings
Running Maintenance Shed Track No. 4
Wheel Shift Incident
of Guangzhou-Shenzhen-Hong Kong
Express Rail Link (Hong Kong Section)
on 3 April 2018

Date: 27 May 2018

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# Shek Kong Stabling Sidings Running Maintenance Shed Track No. 4 Wheel Shift Incident of Guangzhou-Shenzhen-Hong Kong Express Rail Link (Hong Kong Section) on 3 April 2018

#### 1. The Incident

- 1.1 At around 2115 hours on 3 April 2018 (Tuesday), an MTR depot staff member found that four wheels on two bogies of the last car of Train 0256 had shifted out of position at the Running Maintenance Shed ("RMS") Track No. 4 in Shek Kong Stabling Sidings ("SSS") of the Guangzhou-Shenzhen-Hong Kong Express Rail Link (Hong Kong Section) ("XRL"). Upon investigation, it was found that the incident occurred at around 1930 hours when the incident train was shunted back to RMS.
- 1.2The train wheels position immediately after the incident took place is shown diagrammatically in **Annex 1**.

#### 2. Sequence of events (see Annex 2)

2.1 The key sequence of events for the incident can be broadly divided into three series of actions.

#### a) **Incident reporting**

The on-duty Depot Yard Master ("DYM") was conducting inspection on a working team between RMS Track No. 3 and 4 at around 2115 hours when he found that four wheels on two bogies of Train 0256 coach No. 1 (last car of the train) stabled at RMS Track No. 4 had shifted out of position. He immediately informed the Depot Engineer who confirmed that four out of eight wheels had shifted out of position and the incident was

immediately reported to the Depot Manager and other senior managers within the MTR Corporation ("the Corporation") in accordance with the protocol. Although the incident only occurred within the maintenance area (not accessible to the public), after due considerations of the situation, the Electrical and Mechanical Services Department – Railway Branch ("EMSD-RB") was notified at 2200 hours.

#### b) Immediate actions and recovery measures undertaken

The MTR Rapid Response Units and in-house experts on rail investigation were mobilized in accordance with the protocol after the incident was reported. The site was immediately cordoned off and traction current on RMS Track No. 3 and 4 was switched off to facilitate investigation and recovery actions. The Corporation set up an investigation panel ("the Panel") which carried out a detailed investigation to identify the cause of the incident. The Corporation notified the train manufacturer CRRC Qingdao Sifang ("Sifang") of the incident, and Sifang confirmed that a team of experts would arrive by air on the following day (4 April 2018) to assist with the investigation and recovery. The Corporation also invited an independent railway expert from the Monash University Institute of Railway Technology ("IRT") to assist in the investigation. The Corporation temporarily suspended the trial running of XRL trains and the use of RMS Track No. 4 pending the results of further investigation and safety assurance. After the initial investigation as well as a number of recovery actions and safety checks at the incident site, the wheels of the last car of the incident train were re-positioned and shunted towards the northern end of RMS Track No. 4 in the early morning of 5 April 2018.

# c) Post-incident initial investigation and resumption of trial running of XRL trains

On-site measurements by the Corporation's in-house experts on rail investigation revealed that the track gauges over the affected section in RMS Track No. 4 ranged from 1,436mm to 1,525mm (exceeding the

standard dimension of 1,435mm with +8mm/-6mm tolerance), causing the wheels shifted out of position. The location of the wheel drop point on the right-hand side rail at 1.65m from the tangent to the 180m radius curve was identified. Slacking of the I-beam in the elevated track section for the left-hand side rail was found.

The experts from Sifang inspected the incident train and confirmed that there was no anomaly except the slight damages to the car body and the two concerned bogies on last car of the incident train which were caused by the wheel shift incident. Sifang subsequently concluded on 17 April 2018 that the incident train conformed to the operational requirements of XRL and the train did not contribute to the cause of the incident.

The independent railway expert from IRT conducted site investigation and was of the view that the incident had occurred in a site-specific situation that is unique to RMS Track No. 4 at SSS. The expert had taken rail and wheel profiles, track alignment measurements from the incident site and car dimensions related to the incident. IRT has confirmed that they concur with the Corporation's findings that this incident is a site-specific issue.

There are four maintenance tracks at RMS. Following the incident, the Corporation installed video camera to check the wheel running condition and confirmed that there is no flange contact to push against the rail head on the other three maintenance tracks which are straight without any curve.

A special track inspection which measured RMS Track No. 1-3 was conducted by the Corporation's maintenance department and it was confirmed that the track gauge is within acceptable maintenance limit. The relevant construction records for the rails and track supporting structures of the four maintenance tracks in RMS were checked and reviewed by the Corporation's project management team with no anomaly identified.

The results of a detailed structural analysis for RMS Track No. 1-3, i.e. straight track, conducted by the Detailed Design Consultant, Ove Arup & Partners ("ARUP") confirmed that the supporting structure assembly can cater for the actual loading of XRL trains on RMS Track No. 1-3.

It was concluded that the incident did not have any correlation with the trains, the rail including the mainline and RMS Track No. 1 - 3 which are all in good condition. The Corporation obtained no objection from the relevant Government department to resume trial running of XRL trains starting from 13 April 2018 except that RMS Track No. 4 will continue to be suspended for use until further notice.

Meanwhile, the Corporation's maintenance department continues to conduct manual measurement of track gauge in SSS until the completion of the RMS track modification works for the resumption of use without restrictions.

#### 3. Root Cause of the Incident

- 3.1 The RMS tracks involve two design parties. The running rail and rail fastenings were designed (and built) by the contractor responsible for the trackworks (P-Way). A separate Detailed Design Consultant, ARUP, was responsible for the design of the I-beam and supporting structure below the rail in the SSS. (See **Annex 1**).
- 3.2The results of the technical investigation revealed that track gauges of 1,436-1,525mm, exceeding the 1,435mm +8mm/-6mm tolerance, were found at the incident track location on the elevated track support section of RMS Track No. 4. With the measured dimensions of the wheelsets all within their specifications and maintenance standards as confirmed by the experts from Sifang after the incident, the conditions of the track gauges explained how the four wheels of the incident

train had shifted out of position. The rail fastenings of RMS Track No. 4 were found to be securely in contact with the rail foot of both rails after the incident. The evidence on site indicated that the I-beams supporting the running rails above had been displaced and were slightly deformed.

- 3.3 While all four maintenance tracks rest on I-beam supporting structures to enable maintenance staff to carry out any necessary works underneath the trains, RMS Track No.4 is the only maintenance track which has a very short 6.6m long curved section with radius 180m at the incident location. The other three maintenance tracks are straight tracks. Both the Corporation's investigation panel and IRT are of the view that the unique track configuration with the existence of this curved section at the incident location on RMS Track No. 4 has a direct bearing on the incident, relatively high lateral forces have been exerted on the I-beam assembly structure supporting the track form even though trains pass through the section at a very low speed of less than 8kph.
- 3.4The Panel has interviewed the detailed design consultant responsible for the design of the I-beam assembly structure supporting the maintenance tracks at RMS. It was identified that the consultant had assumed the lateral forces imposed on the short curved section of RMS Track No.4 would be insignificantly small and therefore adopted the same design for the I-beam assembly structure for all of the four maintenance tracks at RMS.
- 3.5 The actual lateral forces exerted by the train wheels at RMS Track No. 4 have exceeded the original design assumptions used by the detailed design consultant and this is considered to be the root cause of this incident. With repeated running of trains over that section since April 2017, the track support assembly eventually succumbed during the passage of the incident train on 3 April 2018.

#### 4. Conclusions

4.1 The wheel shift incident involved only the unique track configuration at RMS Track No. 4 located at SSS. There is no similar elevated curved section along the

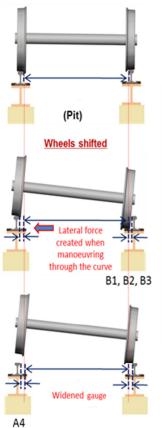
- mainline tracks or anywhere else in XRL. The section of R180m curve measuring 6.6m is a small section of RMS Track No. 4 which has a total length of 435m.
- 4.2 The investigation of both the Corporation and the independent expert from IRT confirmed this is a unique site-specific issue at RMS Track No. 4.
- 4.3 With the conditions of the incident train confirmed to be all within specifications and maintenance standards together with the rails and rail fastenings found to be securely in place, they are ruled out to be the cause of the incident.
- 4.4 It is evident that the detailed design consultant's assumption of a very small lateral force on the structural track support system at this unique elevated curved track is not sufficient for the track supporting I-beam to withstand the actual lateral forces. This is supported by the displacement and slight deformation of the I-beam found at the incident site.
- 4.5 In the post incident investigation and thorough review of the as-built conditions of the mainline tracks and the other RMS Track No. 1-3, it is confirmed that the conditions leading to this incident do not exist anywhere else in XRL. The overall design and construction of the mainline are in accordance with established international high speed rail standards. After the incident, the Corporation has checked all tracks of the XRL, including the mainline and other maintenance tracks, and confirmed they are in good order.
- 4.6 The running maintenance tracks are located in an area that is out of bounds to the public and are used only by not-in-service trains which travel at very low speed. The deficiency of this unique elevated curved section of the RMS Track No. 4 was identified in the initial stage of XRL trial operations which began on 1 April 2018.
- 4.7 This incident occurred on a maintenance track inside SSS where trains operate at very low speed, hence the impact was low and there was no injury. This localised problem will be addressed vigorously and there is regular inspection and measurement to monitor and control the track gauge condition. Hence, there will be no impact on the XRL programme.

#### 5. Recommended Improvements

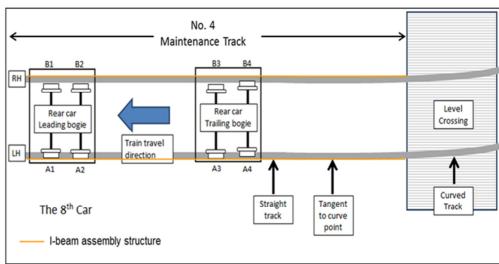
5.1 To prevent recurrence, the Corporation is now working on an improvement measure to strengthen the track support assembly on this curved section of RMS Track No. 4 so as to re-open RMS Track No. 4 for use. It is proposed to enhance the track support assembly at the curved section, by replacing the section of I beams and vertical supports with two reinforced concrete walls under the rails. With this enhancement, the structure can withstand the actual lateral forces while still allowing maintenance works to be carried out underneath the train. Formal submission of the design proposal will be submitted to relevant Government bureaus/ departments for their review before implementation.

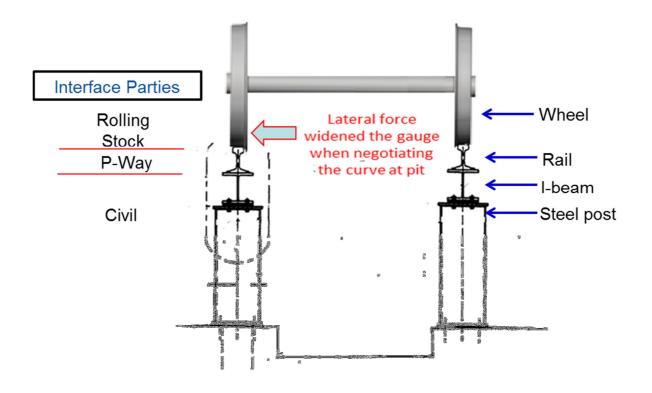
#### Annex 1

#### Normal Wheel Rail Interaction



#### Diagram Showing the position of the train wheels





Annex 2 Sequence of events for the Incident on 3 April 2018

Time	Event	
3 April 2018		
1933 hours	Train 0256 moved into SSS RMS Track No. 4 for checking after completion of daily trial run.	
2115 hours	DYM informed that, while he was on the way to carry out works inspection on a working team between RMS Track No. 3 and 4, he found that some wheels of two bogies of Train 0256 coach 01 (last car of the train) stabled at RMS Track No. 4 were not on the track. Depot Engineer carried out an immediate check and confirmed that four wheels had shifted out of position.	
2120 hours	RS-RRU arrived at the incident site.	
2200 hours	Notified EMSD-RB.	
2245 hours	The Corporation's senior management arrived at the incident site.	
2315 hours	EMSD-RB arrived at the incident site.	
4 April 2018		
0215 hours	The first press statement on the incident was issued.	
0230 hours	All parties left the scene except RS staff for on-site monitoring. RS staff were scheduled to discuss with Sifang for a proper recovery measure to reposition the train.	
1330 hours	Sifang representatives arrived at the site for investigation.	
1530 hours	Railway expert from IRT arrived at the site for investigation.	

Time	Event
1730 hours	RS staff started to recover the two incident bogies to bring them back to track.
1845 hours	A media standup was held to provide information on the incident.
2030 hours	The two incident bogies were recovered on the tracks.
2100 hours	IMD started the track gauge inspection and adjustment.
2200 hours	The second press statement on the incident was issued.
5 April 2018	
0000 hours	The affected section of RMS Track No. 4 was re-adjusted to acceptable values and it was confirmed that RMS Track No. 4 was safe for train shunting at low speed.
0030 hours	MTR Projects team and Sifang inspected the train underframe and confirmed the train was fit to shunt.
0045 hours	Train 0256 was shunted towards the buffer stop at the end of RMS Track No. 4.

### Glossary

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DYM	Depot Yard Master
<b>EMSD-RB</b>	<b>Electrical and Mechanical Services Department-Railways</b>
	Branch
IMD	Infrastructure Maintenance Department
IRT	Monash University Institute of Railway Technology
RMS	Running Maintenance Shed
SSS	Shek Kong Stabling Sidings
RS	Rolling Stock
RS-RRU	Rolling Stock-Rapid Response Unit
Sifang	CRRC Qingdao Sifang
XRL	Express Rail Link

# **END**



# 新聞稿

#### **Press Release**

PRESS STATEMENT

4 April 2018

#### **Express Rail Link Shek Kong Stabling Sidings**

The MTR Corporation would like to provide information on an occurrence inside the Shek Kong Stabling Sidings of Guangzhou-Shenzhen-Hong Express Rail Link (Hong Kong Section) ("XRL") which took place last night (3 April 2018) and may be of interest to the public.

At about 9:15 pm, a depot staff was conducting inspection and he found some wheels of the last car of an XRL train stabled at the maintenance shed had shifted out of position. The occurrence did not cause any injured. The train concerned returned to the depot earlier yesterday after a trial run with no passenger on board.

The Corporation is very concerned about the occurrence and a thorough investigation will be conducted. It has also informed Electrical and Mechanical Services Department of the occurrence.

- End -





# 新聞稿

# **Press Release**

PRESS STATEMENT 4 April 2018

#### **Express Rail Link Shek Kong Stabling Sidings**

The MTR Corporation would like to provide additional information on an occurrence which took place at the Shek Kong Stabling Sidings of the Guangzhou-Shenzhen-Hong Kong Express Rail Link (Hong Kong Section) ("XRL") yesterday (3 April 2018) which may be of interest to the public.

At around 9:15pm, a depot staff member was conducting an inspection when he found that four wheels of the last car of an XRL train stabled at the maintenance shed had shifted out of position. The occurrence did not cause any injury.

The Corporation is very concerned about the occurrence. An investigation has commenced including involving rolling stock and rail track experts to ascertain the cause of the occurrence.

The preliminary investigation showed that the train concerned had been operating normally. Causes related to train and rail have been ruled out based on preliminary findings. An initial inspection also found an I-beam structure which supports a section of rail at No.4 maintenance track at the depot is slightly deformed. Engineering staff will try to ascertain the cause of the occurrence in accordance with this direction. During the investigation, this maintenance track has been temporarily suspended for use.

There are another three maintenance tracks at the depot which can meet the needs during the trial run. The Corporation will check all of maintenance tracks at the depot to ensure they are in good condition.

Meanwhile, other trial operating activities such as those on station facilities systems will not be affected. The occurrence does not have impact on the trial run as a whole and the high speed rail service commencement. The Corporation will closely monitor the situation nevertheless.

The Corporation will submit a report to relevant government departments after a detailed investigation has been completed.

- End -

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# 新聞稿

#### **Press Release**

PRESS STATEMENT 13 April 2018

#### Update on the 3<sup>rd</sup> April Incident at Express Rail Link Shek Kong Stabling Sidings

The MTR Corporation would like to provide additional information on the incident that took place at the Shek Kong Stabling Sidings ("SSS") of the Guangzhou-Shenzhen-Hong Kong Express Rail Link (Hong Kong Section) ("XRL") last Tuesday (3 April 2018):

The MTR Corporation is very concerned about the incident and started an investigation straight away to determine the cause as well as the way to prevent recurrence. While the trial running of XRL trains was stopped immediately, other trial operation activities, such as those involving station facilities and systems have continued.

From the investigation, it was determined that the first seven cars of the concerned train were resting in their normal position on the No. 4 maintenance track of the depot, however four wheels on two bogies of the last car of the train had shifted out of position, with three wheels on the right-hand side dropping below the rail and one on the left-hand side slightly lifted. The I-beam assembly structure supporting this section of the rail was found slightly deformed resulting in widening of the track gauge and the consequential shifting of the wheels by 2.2 inches to 3.3 inches horizontally out of position from the rail. (See attached illustration)

Experts from the Corporation (including rolling stock and track specialists), from XRL rolling stock supplier as well as from an independent track specialist are involved in the investigation. After careful examination, it has been confirmed that the train and the rail concerned are in good order at the SSS when the incident happened.

Based on the findings, the experts attributed the incident to site-specific factors and concluded that the deformation of the I-beam assembly structure was caused by the unique feature of that section, i.e. a relatively sharp curved rail section in the No. 4 maintenance track supported by the I-beam assembly structure. The location concerned is the only place in the whole of the XRL where a curved track section is supported by an I-beam assembly structure. When trains travelled through that section at low speed for berthing, they manoeuvred through the relatively tight curve generating lateral forces. As the I-beam assembly structure was unable to sustain the lateral forces over time, it experienced some deformation and widened the gauge of the track concerned, causing certain wheels of the last car of the train to shift out of position. The No.4 maintenance track has been in use since April 2017.

The Corporation confirmed that all rails as well as other structures of the maintenance tracks at the maintenance shed of XRL were built in accordance with the design standards and safety requirements. As in the commissioning of all new railways, trial operations are being carried out to confirm vigorously if the designs are fully compatible with the actual conditions of usage so that any enhancement can be made where necessary before the railway is put into revenue service.



The Corporation is working with the design consultant to develop a scheme to modify and strengthen the I-beam assembly structure in the concerned section. The incident that took place at the SSS No.4 maintenance track on 3 April is related to the unique feature of a tightly curved track section with I-beam assembly structure in the maintenance track. The remaining three maintenance tracks in the SSS maintenance shed are all on straight alignment, which had been thoroughly checked to be in good condition. The XRL mainline track is supported robustly on concrete slabs or concrete tie structures. The mainline track does not need to provide a large space underneath the train for maintenance and hence no I-beam assembly structure is required.

With the consent of the relevant Government departments, the trial running of XRL trains can resume. The Corporation will resume trial running today (13 April), with the No. 4 maintenance track closed for use until the necessary enhancement has been fully implemented. The temporary closure of No.4 maintenance track has no impact on the trial operation programme.

Further to the preliminary findings, the investigation will continue to examine whether any other measures can be taken to enhance the performance of the No. 4 maintenance track. The Corporation will submit a report to the Government when the investigation has been completed. The public will be kept informed of the findings in due course.

- End -

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