



Preliminary Post Incident Inspection

Incident: 140307 - Rushbrooke rock fall
176mp 100 yards

Incident Background

At 22:40 on the 7th March 2014, a rock fall occurred at 176miles and 100 yards on the Down line between Rushbrooke and Cobh Stations on the Cork to Cobh line. (Between OBC434 & OBC435) The rockfall fouled both rails of the Down line (see figure 4).

The line was under possession at the time to facilitate the renewal of bridge OBC435 as per weekly circular 3600, W/E 09/03/14. Staff who were working at OBC435 heard the rocks fall and went to investigate. The Down line was blocked as a result of the debris.

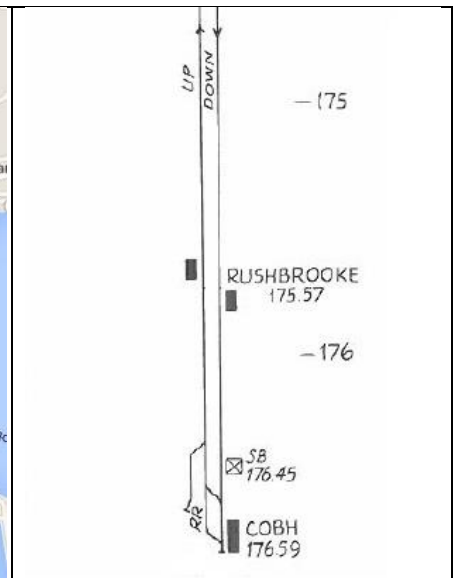
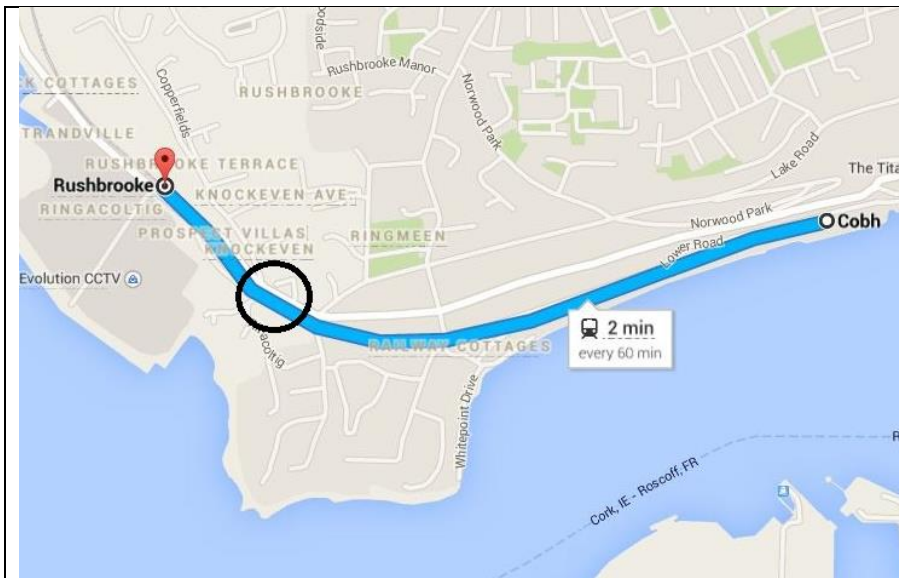


Figure 1 – Location map – (circle indicates the location of the rockfall)

Figure 2 - Extract from Quail map



Figure 3 – Plan of incident location (Lidar)

Figure 4 – Photograph of rockfall (photograph facing UP to Cork)

Parties involved

- Iarnród Éireann – Infrastructure Manager (IÉ-IM) owns and maintains the railway infrastructure at the accident site. The accident location is within the Limerick Junction Division.
- The Chief Civil Engineers’ (CCE) department is the responsible unit within IÉ-IM for the inspection and maintenance of track and structures that include cuttings and embankments.

Location of the incident

The incident happened 500 yards south of Rushbrooke station at 176miles and 100 yards on the Cork-Cobh Down line between overbridges OBC434 & OBC435. (See figures 1-4)

The Infrastructure

The railway at this location is a double line railway comprised of CWR flat bottomed rail on concrete sleepers on ballast formation. The railway runs in a cutting for a distance of less than a mile between Rushbrooke and Cobh. The cutting that failed is relatively steep being approximately 70-80° from horizontal with vegetation thereon. The height of the cutting at this location is circa 6m. The cutting is made up of a fractured sandstone/mudstone with an overburden of soil, the depth of which varies throughout the cutting. A significant amount of vegetation is present on the cutting.

Drainage

On the Down side of the cutting there are local drainage issues. The R624 regional road runs parallel to the railway at the top of the cutting. A significant quantity of water discharges from the roadway to a gully that discharges directly to track level via a drainage down pipe. This is considered an historical arrangement with the Local Authority. The rainfall water is then discharged in to the track drainage.

The land on the Down side (inland side) of the railway falls towards the railway. As a result, the cutting itself is very wet, with water visibly evident dripping off the cutting walls on the down side, with moss forming on the cutting walls in places.

Weather Conditions

(Information from the Met Éireann website from the nearest weather station. i.e. Roches Point)

On the night of the incident;

- Temperatures were mild and between 7°C - 11.5°C
- Rainfall was recorded as 5.5mm on the day of the incident and 17.1mm on the day prior to the incident.

There was however significant rainfall in the 2 months leading up to March with the levels well above average compared to previous years. See Table 1. In February 2014 there was 173.5mm of rainfall compared to 29.5mm and 39.9mm for the same month in 2012 and 2013 respectively.

Table 1- Total rainfall in millimetres for Roches Point (Met Éireann)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2014	148.1	173.5	100.7	69.3	40.8	2.2							534.6
2013	131.5	39.9	104.6	52.5	52.1	96.4	71.8	50.0	25.6	136.4	47.8	161.3	969.9
2012	63.8	29.5	18.1	64.8	60.2	185.4	91.2	147.8	12.9	72.6	83.7	121.1	951.1
2011	60.9	82.6	26.1	24.4	105.0	84.4	31.2	42.3	89.3	67.8	96.7	63.7	774.4
mean	100.5	74.8	78.1	59.0	63.0	63.8	63.1	85.1	85.0	108.9	95.0	99.7	976.0

History of landslips and rockfalls in this cutting

- On 25th January 2013 there was a landslip next to OBC434 on the UP side of the cutting approximately 100 yards from the incident in 2014. This landslip fouled the track gauge of the UP line but did not cover the rails. A passenger service brushed off the landslip.
- In 2006 (date unknown) there was a rockfall on the Down side of the cutting approximately 10m from the incident in March 2014. **Finding 1**

Summary of RSC actions undertaken;

- The RSC issued an RFI to IE - Infrastructure Manager.
- The RSC reviewed all relevant evidence.
- An RSC inspector liaised with IE-accident investigator for the initial incident details.
- RSC inspectors attended the site on the 28th March 2014.
- As part of the preliminary PII, the RSC decided to carry out a number of interviews.
- The RSC interviewed the PWI for the division, the STSE (Limerick Junction) and the RM for the division (Limerick Junction).

Preliminary Post Incident Inspection:

Sources of evidence

Evidence reviewed as part of preliminary PII included;

- Patrol Ganger inspection records for the length in question
- Inspection reports for the cutting
- STSE Limerick Junction Risk Register
- Photographs taken of the rockfall
- CCE inspection standards
- Method statement for the bridge renewal works for OBC435
- Lidar orthophotography (aerial photographic imagery)
- Report by consultant Malachy Walsh for the cutting dated December 2009
- CCE technical investigation into landslip on up road in 2013.
- Interviews with various CCE personnel including; STSE (Limerick Junction), Regional Manager (for the division), PWI (for the division)
- RSC - Post Incident Inspection report for the 'Collision of train with a landslip at the 38 ¼ milepost on the Kilkenny to Waterford line' - 31st December 2013.

Facts relating to the engineering inspection of the cutting

The cutting was inspected in accordance with IÉ-IM CCE Technical standard CCE-STR-STD-2100 - Technical Standard for Structural Inspections.

The following STSE inspections were undertaken:

1. 12/07/2011
2. 06/12/2012
3. Following a landslip on the 25th January 2013

An inspection of the cutting slope by an Engineer took place on the 12th July 2011. This inspection was undertaken by an IÉ Engineer from the STSE Limerick Junction team. A 'Design, Condition, Deterioration' (DCD) rating of 3-3-4 was assigned to the cutting. Water seepage through rock was noted as well as a history of a serious slip/rockfall was noted. The engineer recommended netting or improvement works on the inspection report.

An inspection of the cutting slope by an Engineer took place on the 6th December 2012. This inspection was undertaken by an IE Engineer from the STSE Limerick Junction team. A 'Design, Condition, Deterioration' (DCD) rating of 3-3-4 was assigned to the cutting. Some minor rock falls were noted as well as a lot of water seepage through rock.

Design Ratings Table		Condition Ratings Table	
Design	Rating	Condition	Rating
Fully controls all identified failure modes	1	Good (no faults or minor faults well within tolerance)	1
Controls of identified failure modes have minor weaknesses	2	Fair (tolerable faults, no restriction in use necessary)	2
Controls of identified failure modes have significant weaknesses	3	Poor (significant structural defects, i.e. out-of-tolerance faults)	3
Deficient – fails to control identified failure modes	4	Very poor (seriously deficient, mitigation measures necessary)	4

Deterioration Ratings Table	
Deterioration	Rating
No discernible deterioration (constant failure rate).	1
Slight deterioration (slow increase in failure rate).	2
Discernible deterioration (moderate increase in failure rate). Condition rating expected to increase by 1 in 5 years time.	3
Catastrophic deterioration (rapid or exponential increase in failure rate). Condition rating expected to increase by 2 in 5 years time.	4

Figure 5 – Extract from CCE-STR-STD-2100 showing D-C-D ratings

The condition rating of the cutting scored a '3' in both inspections. As per standard CCE-STR-STD-2100, a condition rating of 3 results in a 5 yearly inspection frequency. It should be noted that this was being over-achieved with an inspection being undertaken annually at this location.

A D-C-D score of 3-3-4 means the following (See figure 5):

- **Design:** Controls of identified failure modes have significant weaknesses
- **Condition:** Poor (significant structural defects, i.e. out-of-tolerance faults)
- **Deterioration:** Catastrophic deterioration (rapid or exponential increase in failure rate). Condition rating expected to increase by 2 in 5 years time.

The cutting slope was inspected by the CCE – Principle Engineer structures after a landslide on the 25th January 2013 and a technical report was completed by the CCE department. This report identified the cause of the landslide to be as a result of

- saturation of the slope of heavily vegetated soil over a rock outcrop

Recommendations made by the report included:

- Undertake clearance works as part of RSP 2014
- Undertake risk based process to determine the exposure to risk caused by the cutting and other cuttings on the network.
- Continue to do the monthly inspections of the cutting as a mitigation measure to the risk of further slips occurring.

No physical works were carried out to the cutting following the inspections of 2011 and 2012. Similarly, following the landslide in 2013 no significant works were undertaken apart from minor tidying up works after the landslide.

Finding 1

Facts relating to Patrol Ganger reports

The cutting was routinely monitored by a Patrol Ganger who walked this length once a week. The Patrol Ganger completed short inspection reports and had routinely stated that the cutting slope (at the location) was unstable and there was a possibility of landslide. No obvious action was taken on foot of these reports. The PWI for the division was aware of the susceptibility of the cutting to landslide/rockfalls and described it as a 'hot spot' that would be monitored and inspected in the event of heavy rainfall. **Finding 2**

Track and Structures Risk Register

As required by CCE Safety Management System standard CCE-SMS-006, 'Hazards and Risk Assessments', (version 3.0), hazards are identified, risks are assessed and precautionary/mitigation measures are implemented to reduce the likelihood and/or severity of those risks occurring.

All hazards are risk assessed in terms of the likelihood of the event occurring and the severity of the outcome. For risks associated with track and structures it is the responsibility of the Senior Track & Structures Engineer (STSE) to ensure that all risks are mitigated to a tolerable level or controlled by effective measures (that cannot be bettered without disproportionate expenditure).

To discharge this responsibility the STSE maintains a register of all known risks. Risk number STR-SJ-0050 was added to the risk register on 28th January 2013 with the following hazard identified "Train strikes rock debris on track and derails". This risk was put on the risk register as a result of the landslip on 25th January 2013.

The mitigation measures to be undertaken were monthly inspections, possible remote monitoring, and possible de-vegetation. The risk had a qualitative pre-risk assessment score of 9 (Likelihood 3 x Severity 3 = Risk 9). The control that was put in place was the monthly inspections for 3 months and this resulted in a residual risk score of 6 (Likelihood 2 x Severity 3 = Risk 6)

The STSE (Limerick Junction) advised that there are 23 cutting and embankment assets in the Limerick junction division that have 12 monthly inspection frequencies in place due to cutting and embankment stability issues. (This is an enhancement to the standard inspection regime.) These 23 assets are not captured on the risk register. The 23 assets are however set up on IAMS to generate 12 monthly notifications for inspection.

(Note: The reasoning for not being placed on the risk register is that the risk register would become overly populated and therefore be less useful in the management of significant risks).

The speed restriction put in place in Rushbrooke to reduce the severity and resultant risk of a train hitting debris was not mentioned on the risk register. (Note: This has subsequently been included on the risk register) **Finding 3**

Bridge renewal

The line between Rushbrooke and Cobh was under possession at the time to facilitate the renewal of bridge OBC435 as per weekly circular 3600, W/E 09/03/14.

The crane for the bridge renewal works was located next to the overbridge OBC435 on the main road. (I.e. approximately 80m from the rockfall location) This resulted in the road that runs parallel to the railway at the top of the cutting being closed. The replacement bridge structure was transported from the Cobh direction and did not travel along the road at the top of the cutting. Therefore, it is reasonable to assume that the bank at this location was not surcharged by the crane or heavy materials associated with the bridge works.

The Road Rail Vehicles being used for the bridge works accessed the track from an access point near Rushbrooke station and travelled to OBC435 bridge site on the opposite track from the rockfall side of the cutting i.e. 'wrong-road-running'. Therefore it is reasonable to assume that the RRV did not come in to contact with the cutting sides causing it to collapse. The RRVs were not near the site of the incident and there were no railway personnel in the immediate vicinity during the incident.

Inspector Recommendations

It is not the purpose of this report to ascertain the cause of the incident but to check if Iarnród Éireann-Infrastructure and specifically the CCE department complied with their SMS. However, from the evidence supplied to the RSC, it is reasonable to assume that the rockfall was caused by the saturation of the cutting in the months prior to the incident given the rainfall levels were well above average compared to previous years. This increased saturation of the cutting and of the soil overburden coupled with the rock in the cutting being of a highly fractured mudstone/sandstone nature make this the most likely cause of the rockfall occurring.

Following a review of all records supplied including interview transcripts, there is sufficient evidence available to confirm, to the satisfaction of the RSC that standards, in relation to the inspection of the asset, were adhered to. Therefore, it is considered unnecessary that a full PII, be undertaken in this instance. Nonetheless, a number of findings have been identified and these lead to the following Post Incident Inspection outcomes:

Finding 1: There has been three landslips/rockfalls in the last 8 years in the cutting between Rushbrooke and Cobh.

39/14-PII-AR 1: Structural assessment and drainage study of the cutting between Rushbrooke and Cobh

The CCE TM should carry out:

An assessment of the structural integrity of the cutting and carry out a drainage survey of the area and subsequently where deemed necessary carry out a programme of physical works to ensure that the risk of landslip/rockfall in the cutting is tolerable.

PCD: 31st October 2014

Finding 2: The patrol ganger was routinely reporting the possibility of a landslide in the cutting for a year prior to the rockfall occurring. This issue was also noted in a similar PII that was carried out by the RSC in March 2014. i.e. 'Collision of train with a landslip at the 38 ¼ milepost on the Kilkenny to Waterford line'. That PII referred to the IM Dublin. The Scope for Improvement is the same except that it refers to the IM Limerick Junction.

39/14-PII-Sfl 1: Review of staff training & competence in earthworks structures for track patrolling staff

The IM Limerick Junction (or their nominated deputy) could consider re-briefing Patrol Gangers on the filling out of Patrol Ganger Reports. In particular this briefing could explain the importance of identifying 'changes' so as to assist the PWI in managing the assets for which they are responsible.

Finding 3: The STSE (Limerick Junction) advised that there are 23 cutting and embankment assets in the Limerick junction division that have 12 monthly inspection frequencies in place due to cutting and embankment stability issues. (This is an enhancement to the standard inspection regime.) These 23 assets are not captured on the risk register. The 23 assets are, however, set up on IAMS to generate 12 monthly notifications for inspection. (Note: The reasoning for not being placed on the risk register is that the risk register would become overly populated and therefore be less useful in the management of significant risks).
The speed restriction put in place in Rushbrooke to reduce the severity and resultant risk of a train hitting debris was not mentioned on the risk register (Note: This has subsequently been included on the risk register)

39/14-PII-AR 2: Review of the Limerick Division Risk Register

The CCE TM should:

- a. critically review the likelihood and severity ratings of all cutting & embankment hazards listed in the Limerick Junction risk register,
- b. ensure all cutting & embankments in the Limerick Junction Division that have associated speed restrictions in place due to cutting & embankment stability issues are placed on the risk register,
- c. review all cutting & embankment risks that have an associated mitigation in place, e.g., increased inspection frequency, confirming they are being managed appropriately

PCD: 31st August 2014

A similar PII that was carried out by the RSC in March 2014. i.e. 'Collision of train with a landslip at the 38 ¼ milepost on the Kilkenny to Waterford line'. A number of the findings from that more in-depth report are applicable in this case and the report should be read in conjunction with this preliminary PII.

Iarnród Éireann actions taken following the incident:

Following the incident, risk mitigation measures were put in place including the implementation of speed restrictions through the cutting and an increased structural inspection programme.

Speed restriction details:

As a result of this incident and previous landslides/rockfalls in the immediate area, speed restrictions have been put in place to mitigate the risk of a train striking rock debris in the cutting at Rushbrooke. The speed restrictions in place on the down side of Rushbrooke Station are as follows:

Down Line:

- 15mph TSR from Rushbrooke (175.1320 MP) to the 176.440 MP. (There is a commencement speed board on the Rushbrooke Down platform)

Up Line:

- 20mph TSR from 176.440 MP to Rushbrooke 175.1320MP
- Speed is normally 50mph (i.e. linespeed)

At the time of writing the speed restrictions are in place and will remain in place until further agreed works are identified and carried out.

Increased inspection frequency:

The STSE increased the frequency of inspection at this location to monthly inspections for 3 months after the incident. They have now been relaxed to quarterly inspections.

STSE - Risk Register:

Risk STR-LJ-0057 for the Rock Fall at Rushbrooke - Cobh has been populated with all relevant Speed Restriction information.

Physical works:

The CCE have carried out works in April 2014 that entailed the removal of weathered rock in a number of areas and further removal and tidying up of the rock at the slip site. A redundant section of retaining wall has been removed, felling of trees and removal of vegetation on the cutting tops. They have also carried out the removal and re-grading of soil material on cutting faces in a number of areas and de-vegetation in 1m strips to allow better inspection of the cutting.

Future works:

CCE are currently assessing further works that may be required. These may include rock/soil nailing, rock/soil netting, shotcreting and drainage.

Signatories

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Signed



Dated

21.07.2014

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22.07.2014

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Dated

22.07.2014