Operational responses to geotechnical asset failures impacting on transportation infrastructure.

BEAR Scotland North West Trunk Road Maintenance – efficient management of geotechnical emergencies.

27 October 2017

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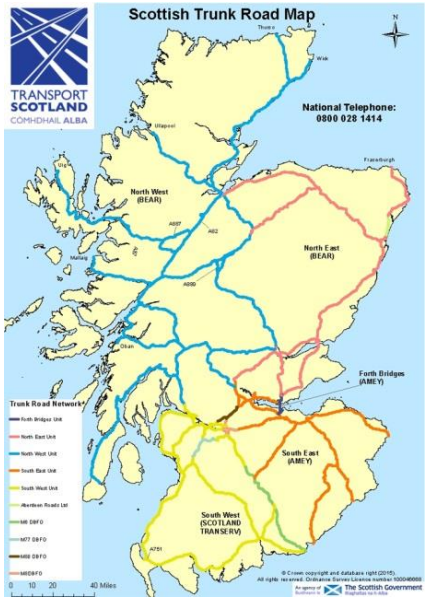
Content

- Trunk Road management in Scotland
- Nature of geotechnical assets
- NW unit landslide management plan
- Case studies:
  - Embankment failure supporting A9 at Loch Insh
  - Landslide onto A83 at Rest and Be Thankful

Trunk Road Management in Scotland

- BEAR Scotland is the Operating Company for Trunk Roads in NW and NE of Scotland
- Responsible for the improvement and maintenance of over 2000km of Trunk Roads
- Key routes include A9 (Perth to Scrabster), A83 (Tarbet – Lochgilphead – Kenacraig) – [focus of two case studies]



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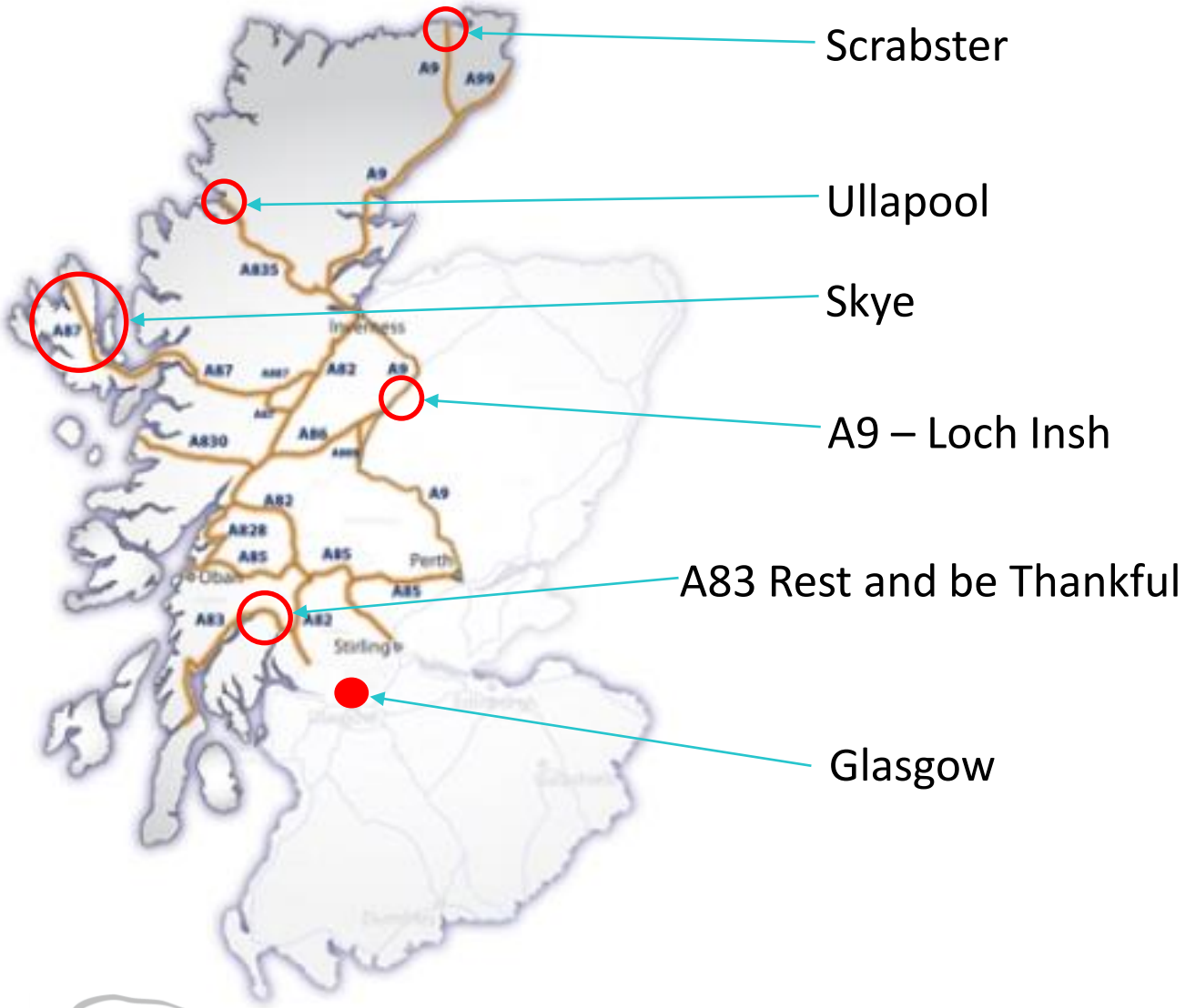
North West Scotland Trunk Roads



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Nature of geotechnical assets

- Embankments
- Cuttings
- Retaining walls
- Rock slopes
- Debris barriers
- Drainage networks
- *Natural terrain in vicinity of Trunk Roads*

Landslide Management Plan

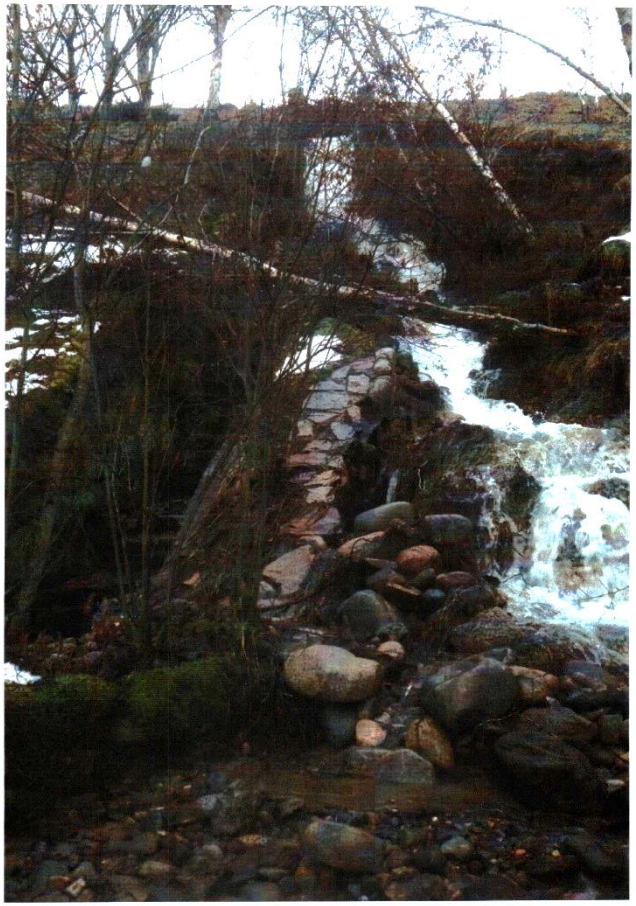
- August 2004 events
  - A83 Glen Kinglas (Cairndow)
  - A9 (north of Dunkeld)
  - A85 Glen Ogle
- Development of Landslide Management Plan (LMP)
- How LMP is implemented

Embankment failure supporting A9 at Loch Insh

Key information

- Cause: embankment washout failure
- Date: 22 December 2014
- Scale: failure ~10m high and 10m to 20m wide
- Failed section of embankment 30+ years old
- Quantity of imported material ~5,000t
- Cost of remedial repair ~£80k

A9 Loch Insh – pre and post failure



Pre failure

Post Failure

A9 Loch Insh – remedial works

A9 Loch Insh – temporary construction drainage

A9 Loch Insh - completed remedial works

A83 at Rest and be Thankful (RaBT) Phase 1 Landslide

Key information

- Cause: two significant debris flows
- Date: 5 and 30 December 2015 (storm Frank)
- Scale: initial failure ~60m above A83, second failure ~240m above A83
- Volume of debris flow: 5 Dec ~400m^3 (intercepted by barrier), 30 Dec ~100m^3 (breached temporary barrier)
- Barrier design capacity: 600m^3
- Cost of repair ~£140k

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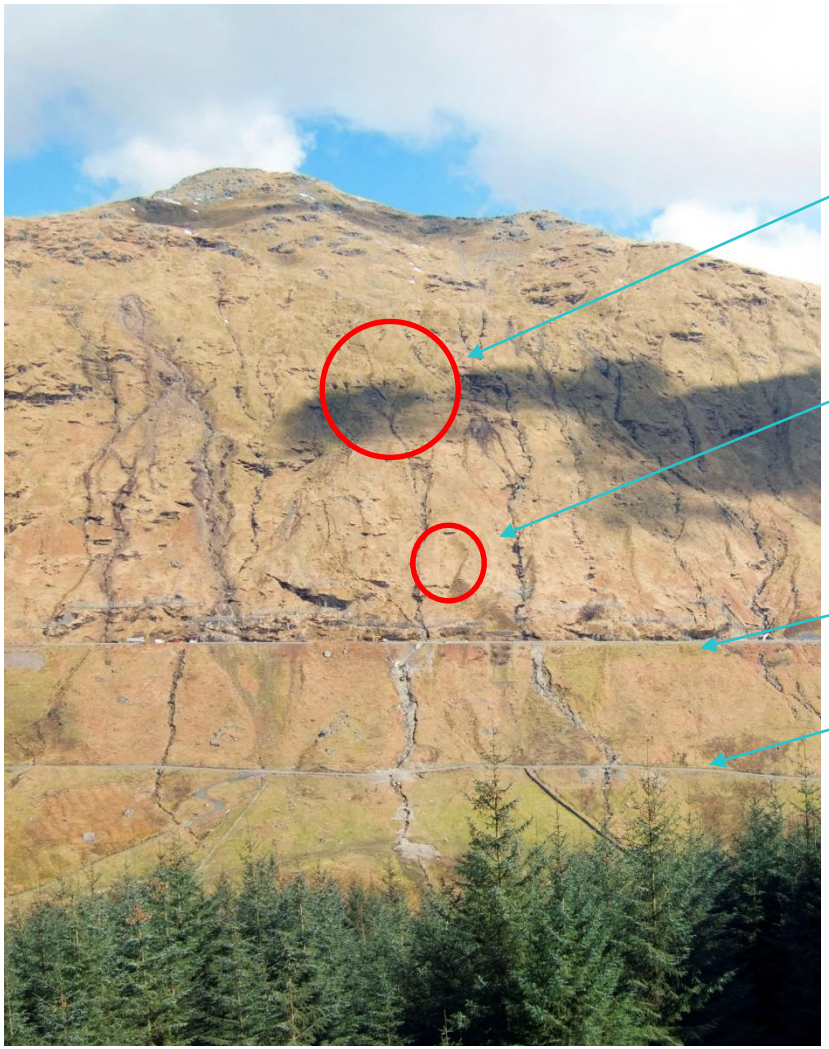
A83 RaBT – hillside prior to events of Dec 2015



Source of second failure
30 December 2015

Source of first failure
5 December 2015

A83 Trunk Road

Old Military Road (temporary diversion route)

Note: photo predates failures and shows earlier failures on hillside

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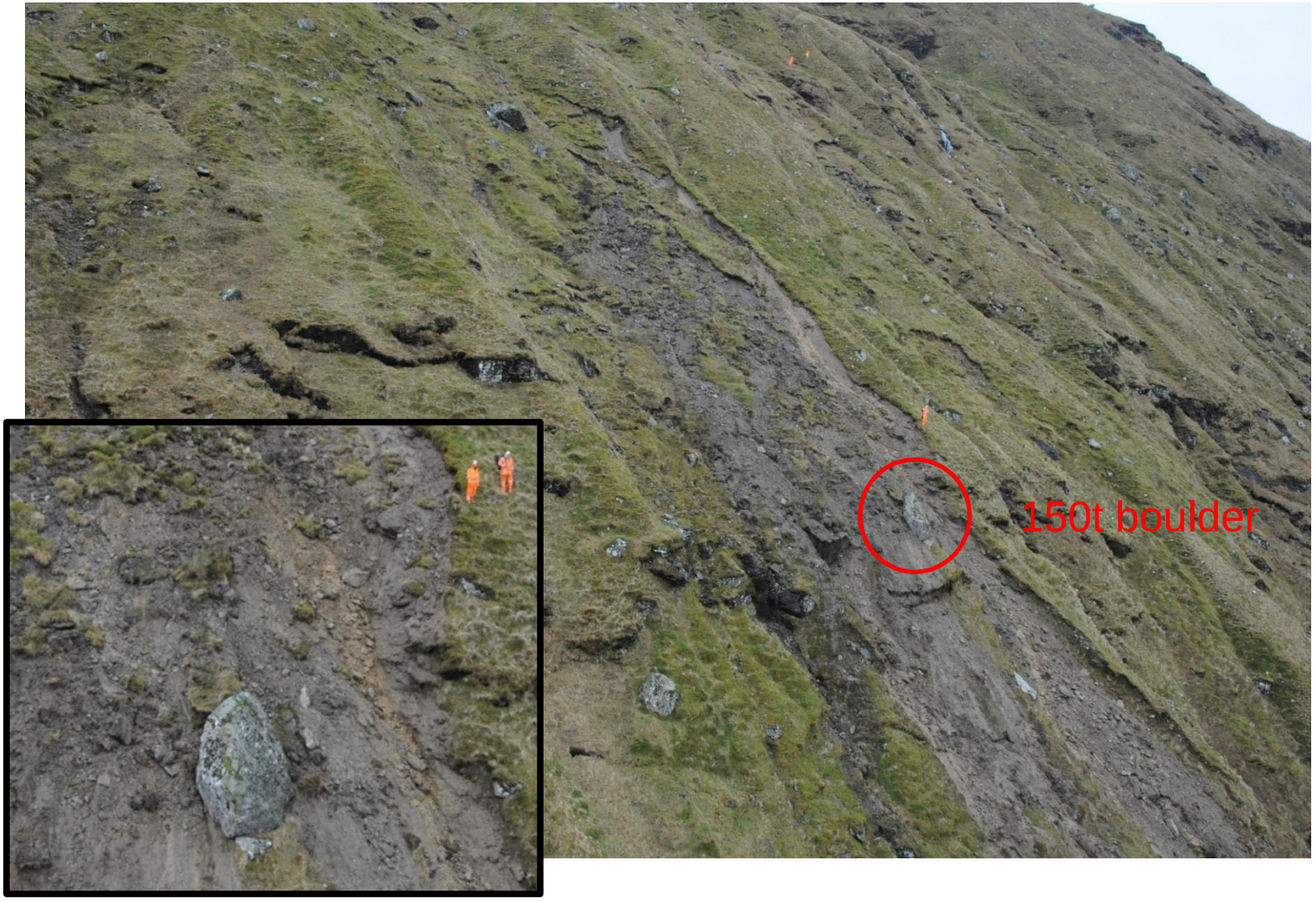
A83 RaBT – 5 December failure

A83 RaBT – consequence of 30 December failure

A83 RaBT – 30 December failure source



Images courtesy of Geo-Rope

A83 RaBT – reducing risk posed by 150t boulder

A83 RaBT – boulder post remediation

A83 RaBT – conclusions

- Dynamic nature of hillside
- Inspect hillside from opposite side of glen
- Exposed boulder inspection following debris flows
- Catch pits considered to augment barriers
- Alternate solutions have been explored:
  - Viaduct
  - Debris flow shelter
  - Road at bottom of glen (along OMR alignment) and tunnel
  - Alternative routes

Concluding remarks

- Safety of road users is the key consideration in geotechnical decisions
- The uniqueness of parts of the Scottish Trunk Road Network requires a pragmatic approach to dealing with geotechnical asset failures
- Solution is typically to remediate, i.e. as good as before or better (not necessarily to code)
- By combining the strengths of various organisations, cost effective and timely solutions can be delivered to benefit road users
- Lessons used on design of new infrastructure

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Thank You.

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