

Shared Learning from a Formal Investigation



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Title: **Designing and installing chemical anchors for post-drilled fixings**

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Photograph of failed stud

Underlying Causes:

Anchor Selection and Design

The design of the connection between the studs and tunnel lining was inadequate given the actions on the structure and the condition of the substrate that the anchors were embedded in.

The resin was probably selected using inadequate technical data and, with no on-site testing having taken place during the design phase, was not compatible with the tunnel brickwork. The resin that was ultimately selected may have been softened by water percolating through the brickwork; and resin shrinkage may have reduced the bond between studs, resin and brickwork.

Quality Control

It is probable that insufficient resin was placed round the studs during installation in 1998/9.

The extent of supervision and quality control of the site work was unclear due to the lack of records, and the method of testing specified by the designer did not reveal any shortcomings in the stud installation process.

There was no evidence that NR and its designers were aware of published reports which indicated a problem with the durability of polyester resin in damp conditions.

Overview of Event

On 23 September 2011, Balcombe Tunnel on the London to Brighton Main Line was closed due to the partial failure of one of the water catchment trays fixed to the upper part of the tunnel lining. Three consecutive support beams had become detached from the tunnel lining at one end and the metal structure had sagged above the Up line; no trains had been struck when rail traffic was suspended. The failure was investigated and remedial works installed before reopening to rail traffic.

The industry and [RAIB investigation](#) found a large number of contributory issues.

This Shared Learning highlights the importance of:

- specifying appropriate fixings for the location and usage, and
- following correct design and installation processes.

Guidance Available

Since the incident, the British Standards Institution (BSI) has issued 'BS 8539:2012 Code of practice for the selection and installation of post-installed anchors in concrete and masonry'. BS 8539 applies to all fixings drilled into concrete or masonry (i.e. bricks, blocks or stones), and not just in tunnels.

BS 8539, Section 4, contains clearly defined roles and responsibilities for: Manufacturer/supplier; Designer; Specifier; Contractor; Installer; Supervisor and Tester. Each needs to be competent.

- Any person who at any time changes a specification without notifying the original specifier is deemed to have taken on the role and responsibilities of the specifier (this includes changes made on site).

Key Message: The risk of functional failure of post-installed anchors should be addressed in Building and Civil Engineering Assurance forms (as prescribed in NR/L2/CIV/003) and accompanying design / project risk records. That process must also identify appropriate mitigation measures which should include implementing the requirements of BS 8539:2012 when selecting, designing and installing post-installed anchors in masonry and concrete.