

# Alternative Methods for Patch Repairs in Tunnels

## What is the situation?

The rise in passenger and freight traffic means reduced access time for inspection and repair.

The current forecast for 2030 is 34% increase in passenger traffic and 40% increase in freight traffic (compared to a 2005 baseline). Reduced possession availability for tunnel remediation will result in more extensive time, cost consuming, complex repairs as these assets get older.

Our current policy is to maintain the tunnels for continued serviceability, extending tunnel service life is seen as a major priority to facilitate the UK and Europe's rail transport ambitions.

Current repair methods and access arrangements are not appropriate for the forecast demands of the railway.

To appropriately manage the risks associated with tunnel assets, it is necessary to develop new repairing, strengthening methods and materials which cause less traffic disturbance. Fast and safe installation is needed within the short track access times. Using limited materials that require excessive manual handling.

In addition, a number of repairs undertaken currently require formwork, which often impacts on gauge constraints within tunnels, or sprayed concrete which requires specialised equipment and lengthy curing times before reaching full strength.

With future demands on the railway and less access time, it is important that repairs can be carried out as efficiently as possible during shorter possession times.

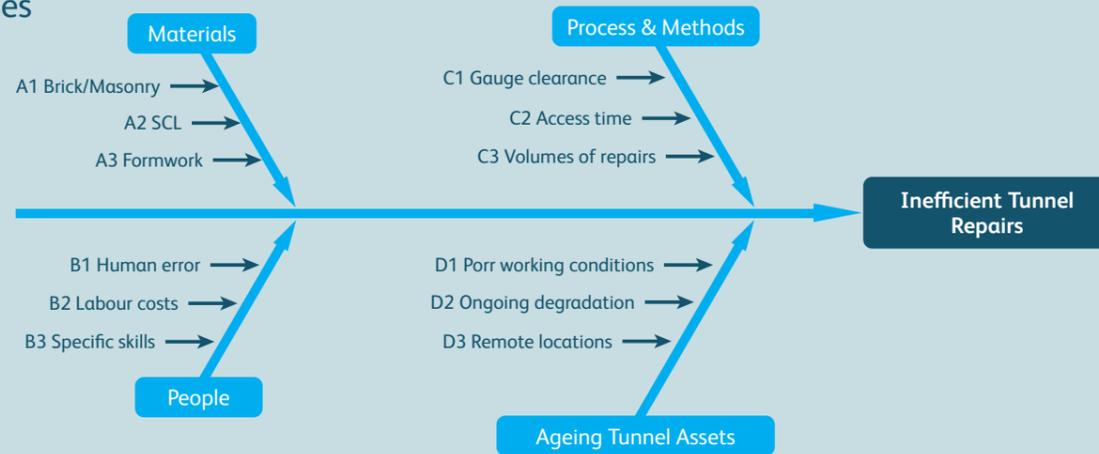


fig. 1



fig. 2

## Analysis of causes



## Priority problems

### Specific priority problems

- Insufficient access to maintain the tunnels at an efficient rate to maintain serviceability and safety.
- Current repair methods are becoming inadequate given high rate of degradation of tunnel assets.
- Low achievable volumes of maintenance.
- Gauge infringement incidents due to current temporary works measures.
- Large quantity of material required for current repairs.

### Related goals

- Repairs can be carried out faster and safer inside shorter possessions.
- More advanced repair materials delivered through efficient means.
- Repairs will have faster application and curing times to allow more repairs to be completed.
- Formwork not required for repairs.
- Minimise materials and equipment needed in the tunnels for repairs.

### Benefits

- Reduced railway disruption and lines returned to service quicker.
- Sustainability with maintaining tunnel condition i.e. required level of serviceability as the assets age.
- Reduced overall cost and time taken to carry out repairs.
- Safer and reduces need to re-enter tunnel to remove formwork.
- Reduce manual handling and reduced material cost for repairs.

## Scope

Repair materials that can be deployed quickly and safely within tunnels, by non specialised workers, are required to improve efficiency in tunnel repairs. This will reduce the number and length of possessions required to carry out maintenance work.

This new repair method should allow for minimal materials and equipment being brought into tunnels for repairs, shortening the time required to complete a patch repair. Allowing lines to return to operation more quickly.

The improvement works should focus on the replacement of original damaged brickwork with new materials that should be developed not to degrade in a tunnel environment. Additionally, they must prevent further degradation and avoid the need for additional intervention.

## Specific research needs

To address these challenges it is expected that R&D actions will need to address the following aspects:

- How can repairs be carried out faster and safer inside shorter possessions?
- How can innovative repair materials be applied and delivered efficiently?
- Are there innovative solutions that can negate the need for temporary works? What can be done or what alternatives can be used to optimise materials and equipment needed in the tunnels for repairs?

## Expected impact & benefits

- Reduced railway disruption and lines returned to service quicker.
- Sustainability with maintaining tunnel condition i.e. required level of serviceability as the assets age.
- Reduced overall cost and time taken to carry out repairs.
- Safer and reduces need to re-enter tunnel to remove temporary works.
- Reduce manual handling and reduced material cost for repairs.
- Reduce the reliance on existing diminishing skill sets.

## Examples

There are a few concepts under development that could fulfil this challenge statement. Examples shown below include UV liners used in culverts; the material is fed through the culvert via a machine and then enlarged to fit the circumference of the culvert. UV light is then used to strengthen the material providing a new lining with no excavation or maintenance engineers required.

Another option is the use of 3D printed materials, such as titanium, to fit perfectly within repair locations to speed up repairs and make them more accurate for onsite installation. With decreasing number of experienced bricklayers working in tunnels it is important to find solutions that are less reliant on these specialised tradesmen.

**Example 1:**  
UV Culvert Liners used to reline culverts.



**Example 2:**  
3D printed bricks could be used for specific repairs.

