**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 a 34% increase in passenger traffic and a 60% 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.

With future demands on the railway and less access time, it is important that repairs can be carried out as efficiently as possible during sprayed concrete which requires specialised equipment and lengthy curing times before reaching full strength. In addition, a number of repairs undertaken currently require formwork, which often impacts on gauge constraints within tunnels, or materials which cause less traffic disturbance. Fast and safe installation is needed within the short track access times. Using limited To appropriately manage the risks associated with tunnel assets, it is necessary to develop new repairing, strengthening methods and 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.

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.

**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 temporary works.
- Reduce manual handling and reduced material cost for repairs.
- Reduce the reliance on existing diminishing skill sets.

**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**

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

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

**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?