



STRUCTURE SLIDING

With Freyssinet's structure sliding technique, a subway or underpass is built to one side of the track. When the rail blockade has been secured, the track and embankment are excavated and the structure is slid from its constructed position to its final position. The use of this method frequently reduces risk, cost and blockade time.

The **Autoripage®** technique consists of clearing the embankment over the width of the underpass and sliding the structure on bentonite using 1,000-tonne jacks. Once the sliding is complete, backfilling takes place in order to open the route to rail services. The world record slide is a structure weighing 21,000 tonnes.

The **Autofoncage®** technique is similar but the excavation and sliding are done simultaneously, which can reduce dig and backfill volumes.

A third method, called **Air Pad Sliding™**, uses vertical jacks on hover pads running along steel skidways to move the structure. The embankment needs to be excavated and backfilled as with Autoripage but on structures lighter than 2500 tonnes the Air Pad Sliding method can offer some advantages.

On Christmas Day 2015, Freyssinet slid a reinforced concrete bridge box, measuring 39x18x11m high and weighing approximately 3750 tonnes, a distance of 41 metres under the Immingham to Ulceby railway line in North East Lincolnshire using Freyssinet's Autofoncage® method.



SLOPE STABILIZATION

Freyssinet can supply a variety of anchors and nails to stabilize rail embankments and cuttings.

Ground Anchors

Ground anchors transmit the forces from a structure to the ground in which they are anchored. They are stressed using a hydraulic jack. Freyssinet ground anchors may be single or double corrosion protected, depending on the application required.

Soil Nails & Rock Bolts

These anchors are created using bars inserted in a bore hole and held in place using grouting or a mechanical anchor. Their purpose is to improve the resistance of the ground.

Soil nails are 20 to 50mm diameter bars and may be as long as 20m. They are bonded along their entire length by cement grout.

Rock bolts may be used to stabilize the roof and walls of a tunnel and are 15 to 32mm diameter bars. They are generally between 3 and 6m long and may be bonded along their entire length or anchored at various points.

OTHER PRODUCTS

Freyssinet also manufactures and supplies **Bearings, Expansion Joints and Shock Transmission Units** for rail bridges.

Freyssinet has supplied more than 190 bearings and 16 shock transmission units to London Bridge Station.



RAIL CIVIL ENGINEERING INFRASTRUCTURE

Repair & Construction



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BRIDGE JACKING AND BEARING REPLACEMENT

Bridge Jacking

Bridges can be jacked vertically to raise them when more headroom is required or to allow the bearings to be replaced. The jacks are equipped with swivel heads and locking collars are available from 50 to 1000 tonne rating and can be clustered where more capacity is needed.

Flat jacks, which are able to operate in gaps of 50mm or less, are also available up to 1000 tonnes capacity. Jack inflation can be done on oil or grout depending on whether the use is temporary or permanent.

Vertical jacking can also be employed to control settlement and as compensation jacking. This may be required when tunnelling beneath a sensitive or historic building.

Bearing Replacement

Freyssinet's bearing replacement service combines our pre-eminent position as bridge bearing manufacturer and designer with our expertise at design, supply and operation of jacking systems. Our in-house temporary works designers are able to engineer alternative jacking solutions for temporary works which often offer considerable advantages in terms of speed, cost, improved access, and in many situations, do not require temporary foundations or excavation.

Masonry Arches

Freyssinet has successfully developed a method for lifting masonry arch bridges called **ElevArch®**. The technique works by cutting the arch bridge free of its abutments, jacking vertically, then locking it in its new position. A masonry arch relies on arch action to remain stable and Freyssinet's innovative technology ensures this is maintained during the lifting process.

*In October 2016, Freyssinet successfully trialled **ElevArch®** with sponsorship from RSSB in collaboration with Network Rail, as part of its 'Avoidance of Bridge Reconstruction' competition. Over 120 guests from the rail sector were on site to witness the lift trial of a 161-year-old, 220 tonne masonry arch bridge in Buckinghamshire.*



LEAK SEALING AND WATERPROOF MEMBRANES

Leak Sealing

Forces exerted on tunnels, basements and retaining walls over the lifetime of a structure can cause movement and cracking which can let in water.

Polyurethane injection resins have been developed specifically to cure such problems and range from low to high viscosity, slow to rapid reacting, and rigid to flexible performance in order to cover the whole range of situations encountered. The fast reacting gels in the resin quickly seal leaks once they come into contact with water.

Acrylic leak sealing gels are also available and these offer an ultra-low viscosity injection resin for hairline concrete cracks and joints, masonry crack repair and sealing of honeycombed concrete in retaining walls and slabs.

In 2015, Freyssinet was awarded a contract by Strathclyde Partnership for Transport (SPT) to upgrade the network's tunnel lining, as part of the subway's modernisation project. The two year project included annulus grouting, the cleaning of the tunnel lining, concrete and brickwork lining repairs and resin injection leak-sealing.

Waterproof Membranes

Freyssinet can undertake the installation of welded sheet membranes, surface spray-applied membranes and injected chemical leak barriers.

In the summers of 2013, 2014 and 2015, Freyssinet blasted and formed emergency escape tunnels in the Puymorens Tunnel between France and Spain. The escape tunnels are backed by a welded sheet membrane prior to casting the new tunnel wall and crown.



BRICKWORK AND CONCRETE REPAIR

Brickwork Repair

Freyssinet undertakes a complete brickwork repair and replacement service including crack stitching, ring separation pinning, recasing, void grouting, repointing and leak sealing. To help clear the backlog of brickwork patch repair, often in tunnels with very short possession periods, Freyssinet has developed **PanelPatcha™**, a mechanised, high-productivity method of patching or recasing brickwork.

The PanelPatcha method is applicable to multi-span arch viaducts too, where a second Freyssinet innovation **RokArch™** is available to stabilize these, often Grade II, listed structures. As trains traverse such viaducts the triangle of brickwork at the pier-head rocks to and fro causing distress to the piers. Freyssinet's method can solve this with due regard to the aesthetics of the structure.

The 1878 Connaught Tunnel has been enlarged to accommodate Crossrail trains. Freyssinet has completed several packages of work in this brickwork tunnel including leak sealing of cracks, replacing damaged brickwork with sprayed concrete, brickwork patching, stainless steel pinning of separated arch rings and hydrodemolition of honeycombed concrete.

Concrete Repair

Where concrete is in poor condition and has to be replaced, Freyssinet offer removal both by conventional breaking and hydrodemolition, with subsequent replacement using high performance repair concretes and mortars. A wide range of techniques are available for repairing spalled, cracked, damaged, and honeycombed concrete including: modified mortars for patch and thin bond repairs; pressure and vacuum injection using epoxy, polyester, and cementitious grouts; and sprayed concrete.

Other Repair Services

Freyssinet undertakes a wider range of complementary services relating to structural repair, refurbishment and enhancement, including; grit blasting, wall sawing, core drilling, coatings, cathodic protection and carbon fibre strengthening.

SPRAYED CONCRETE AND HYDRODEMOLITION

Sprayed Concrete

Freyssinet has extensive experience of both dry and wet spray techniques. We are able to design specialised mixes, apply client specified mixes and pre-bagged materials. All sprayed concrete is applied by fully certified sprayers, most of whom have many years of experience in 'the art' of doing these types of repair.

Freyssinet's innovative **BigaBore™** tunnel enlargement system exploits the advantages of sprayed concrete. Some tunnels are too small for modern needs, such as OLE on electrified lines and W12 gauge rolling stock. Freyssinet's method cuts chases into the roof and haunches of the tunnel, fixes reinforcement and sprays in concrete to form strengthening ribs. Once cured, the brickwork between the ribs is nibbled back to provide sufficient clearance through the tunnel. It provides a cost-effective and often more user-friendly alternative to track lowering. Freyssinet can carry out the clash detection survey, the geotechnical and structural analyses, and execute all of the site works.

Hydrodemolition

Hydrodemolition utilises high-pressure water jetting to remove deteriorated and sound concrete. It can be used for localised repairs and large-area removal. It can also be used to clean off existing coatings, leaving the substrate ready-keyed to receive its replacement coating application.

Freyssinet repaired the Channel Tunnel after the fire in 2008 using rock bolts to strengthen the crown, hydrodemolition to remove the fractured lining and sprayed concrete to replace 4,000 tonnes of lining.