

**TUNNEL JACKING FOR BOSTON CENTRAL ARTERY PROJECT**

The tunnel jacking for the Central Artery Project in Boston is by far the largest, most complex project of its kind in the world. Requiring a quantum leap in scale – over 10 times the size of any jacked tunnels attempted in the US before – it has involved numerous firsts and major engineering innovations. Recognized as the most challenging component of the Central Artery Project – which will take much of the city's highway network underground, removing heavy traffic congestion and pollution – the tunnel jacking resulted in the successful construction of massive tunnels beneath operating rail tracks while maintaining continuous safe operation of the rail service, and brought substantial benefit to the community.

The original construction concept proposed required five phased relocations of the railroad – an approach unacceptable to the railroad authorities, AMTRAK, and Massachusetts Bay Transportation Authority (MBTA). The alternative, developed by our team, enabled three full-size interstate highway tunnels – over 100m long with single elements weighing up to 30,000 tones – to be jacked under an operating railway with no track relocations, train speed restrictions, or interruptions to the service.

**Innovations:**

1. By far the largest tunnels ever to be jacked beneath operating rail tracks in the USA, in the most challenging ground conditions imaginable for this type of construction.
2. First ever global ground freezing of ground beneath rail tracks to stabilize the ground and allow open face tunnel excavation methods. This required the installation of approximately 2000 vertically installed steel freeze pipes at 7 ft. centers to produce the largest man made ice block with a volume in excess of 250,000 cubic yards.
3. Development and use of a “carpet” of over 900 steel cables, to form an anti-drag laminate both above the tunnel roof and below the tunnel floor.
4. Development of high strength open face tunneling shields and associated improvements to the hydraulically powered excavation equipment.
5. Development of multiple methods to relieve pressures on very large span earth retaining walls due to lateral heave effects during ground freezing.

The size, complexity and innovation of the tunnel jacking have excited the interest and attention of engineers, academia, and public alike. The huge jacking pits in which the tunnels were constructed, which themselves required a range of innovations, won the 2000 American Consulting Engineers Council Grand Award for Engineering Excellence. The tunnels themselves won the 2003 ASCE Civil Engineering Research Foundation, Charles Pankow Award for Innovation in addition to several International Awards for Innovation and Quality. The tunnel jacking demanded strong communication and teamwork between the design and construction teams and the various highway and railway authorities. This work has heightened public awareness of advances in construction and increased appreciation of how civil engineering maintains and improves the infrastructure, which is fundamental to our quality of life.

For more information refer to the cover story in *Civil Engineering*, September 2003

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Aerial View of Construction Site with I-90 Jacking Pits in the Foreground



Jacked Tunnel with Passenger Trains Passing Less than 6 ft. above.



View across tracks showing freeze pipe heads