

“Historic Civil Engineering in the U.K.: EWRI Friends Visit London, York, Edinburgh, Arbroath, and Glasgow for Titan Crane Landmark Ceremony”

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ABSTRACT

In August 2013, several EWRI friends visited London civil engineering projects: Tower Bridge, Brunel Museum and international landmark Thames Tunnel, and the Institution of Civil Engineers (ICE). After a tour of Leeds Castle, Dover, Canterbury Cathedral, and Greenwich, the group took a Thames River cruise under many London bridges. From the renovated London Kings Cross Rail Station, the group visited the National Railway Museum in York or the York Minster. In Edinburgh, we saw the ICE Scotland Museum (Heriot - Watt University), went to an Edinburgh International Festival Concert, and attended the Military Tattoo (Edinburgh Castle). Via the international landmark Forth Rail Bridge to Arbroath, we saw the Bell Rock Lighthouse Signal Tower Museum (David Taylor) and Arbroath Abbey. With other ICE attendees, we stayed at a Glasgow hotel and toured the Auchentoshan Distillery. We had a West Clydebank (Dunbartonshire Council) town hall lecture (by Roland Paxton) about the Titan Crane's designer. At the Titan Crane Landmark plaque ceremonies, with ICE, IMechE, ASCE, and ASME, all went through the Titan Crane Museum, before a Clydebank (West Dunbartonshire Council) town hall civic dinner. We visited the Forth & Clyde Canal 2000 international landmark at Bowling. On an ICE history tour, all visited the largest UK masonry railway arch, Ballochmyle Viaduct (1846-48), a seven arch engineering masterpiece. (The Glasgow & South Western Railway (1850) had a landmark plaque unveiled on 25 April 2014.) Next, the tour stopped at the Dick Institute, Kilmarnock, where an ICE plaque (Kilmarnock & Troon Railway (1812), Scotland's first public railway) was presented to Provost Jim Todd, East Ayrshire Council.

INTRODUCTION

Before attending the Titan Crane International Historic Civil Engineering Landmark (IHCEL) ceremony in Glasgow, several EWRI friends visited London, York, Edinburgh, and Arbroath in August 2013. Along the way, the group toured a number of historic civil engineering, architectural and political/historic sites in the U.K.

LONDON (See Smith (2001), Mathewson et al. (2006), and Ferguson and Chrimes (2011).) Arriving earlier, two couples took an Aug. 12, 2013 guided coach trip to Windsor Castle (home of the British Royal Family for the last 900 years with St. George's Chapel and the State Apartments), Stonehenge and the Roman baths at Bath. From Wikipedia: "Stonehenge is a prehistoric monument located in Wiltshire, England, about 2 miles (3 km) west of Amesbury and 8 miles (13 km) north of Salisbury. One of the most famous sites in the world, Stonehenge is the remains of a ring of standing stones set within earthworks. It is in the middle of the most dense complex of Neolithic and Bronze Age monuments in England, including several hundred burial mounds. Archaeologists believe it was built anywhere from 3000 BC to 2000 BC." Another couple toured Royal Albert Hall (built 1867-1871 for concerts in Kensington). The amphitheater Hall was designed by civil engineers Captain Francis Fowke and Major-General Henry Y.D. Scott and built by Lucas Brothers. On Aug. 13, the three couples took a guided coach tour of Leeds Castle (a 12th-century castle dating to the year 1119, with the castle in 500 acres of parkland and gardens), Dover (with a rest stop overlooking the Cliffs of Dover, Dover Castle and the Dover harbor), Canterbury Cathedral (built in the 11th century with Gothic-style architecture and designated as a UNESCO World Heritage Site), and Greenwich (home of the Royal Observatory and the Prime Meridian, where the world's time is set.) Departing the coach in Greenwich, the group took a Thames River cruise under many London bridges, including three Brunel bridges: Hungerford (I.K. Brunel 1846), Blackfriars Railway Bridge (1886 Wolfe Barry and Henry Marc Brunel), and Tower Bridge (Horace Jones 1894, engineers Wolfe Barry and Henry Marc Brunel), arriving at Embankment Pier.

On Aug. 14, the EWRI group took the London Underground Tube to Tower Hill to the Tower of London. Wikipedia states: "Her Majesty's Royal Palace and Fortress (Tower of London), is a historic castle located on the north bank of the River Thames in central London.....It was founded towards the end of 1066 as part of the Norman Conquest of England. The White Tower, which gives the entire castle its name, was built by William the Conqueror in 1078..... A grand palace early in its history, it served as a royal residence..... As a whole, the Tower is a complex of several buildings set within two concentric rings of defensive walls and a moat." The EWRI group walked from Tower Hill by the Tower of London to Tower Bridge.

From Wikipedia: "Tower Bridge (built 1886-1894) is a combined bascule and suspension bridge.....The bridge consists of two towers tied together at the upper level by means of two horizontal walkways, designed to withstand the horizontal forces exerted by the suspended sections of the bridge on the landward sides of the towers. The vertical component of the forces in the suspended sections and the vertical reactions of the two walkways are carried by the two robust towers. The bascule pivots and operating machinery are housed in the base of each tower. In 1884, a design submitted by Sir Horace Jones, the City Architect (who was also one of the judges), was approved. Jones' engineers, Sir John Wolfe Barry and Henry Marc Brunel, son of I.K. Brunel, developed the final bridge design. The bridge's present color scheme dates from 1977, when it was painted red, white and blue for Queen Elizabeth II's silver jubilee. In 1982, the Tower Bridge Exhibition, a display museum housed in the bridge's twin towers, opened with

high-level walkways and a museum in the Victorian engine rooms. The exhibition uses films, photos and interactive displays to explain why and how Tower Bridge was built." A 2013 international bridges exposition was replaced by: "The Sixties" – a stylish new photographic exhibition on display from 28th March 2014, and a new upper Glass Floor was opened in Dec. 2014. There are spectacular views of the Thames River and the new Shard Tower from the upper floor.



Figure 1. Photo of A.J. Fredrich, Jerry Rogers standing beside the World Heritage Site plaque at Canterbury Cathedral. **Figure 2.** EWRI Group Photo at the 1894 Tower Bridge over the Thames River in London. Photos by Bill Bulloch, A.J. Fredrich, and Jerry Rogers (with permission).

Next, the three couples took the London tube to Rotherhite Station where ASCE and ICE unveiled a 1993 International Historic Civil Engineering Landmark (IHCEL) plaque for the Thames Tunnel.

THAMES TUNNEL, Constructed 1825 – 1843

- **First Shield-Driven Subaqueous Tunnel**
- **Sir Marc Isambard Brunel, Civil Engineer**
- **Presented 25 September, 1993 by ICE and ASCE**

The 2013 ASCE group walked to the nearby Brunel Museum and viewed part of a video: "The Life of Brunel: 1806- 1859," 2006, concerning I.K. Brunel and his father: Marc Brunel, the inventor of the patented tunneling shield utilized to excavate the Thames Tunnel.

From: <http://www.londonreconnections.com/2014/king-of-the-underworld-building-the-thames-tunnel/>, May 21, 2014: "In March 1825, Marc Brunel and the Thames Tunnel Company began tunnel construction.....(After some setbacks and delays, in 1834, a number of Fellows from the Royal Society decided to throw a dinner in Marc Brunel's honor at the Spreading & Crown Pub. They toasted the Engineer's health and formed the "Tunnel Club" – a lobbying group determined to support Brunel's tunnel funding plans; in June, Parliament signed off on a £270,000 loan to complete the Thames Tunnel." The Brunel Museum is in the engine house with an adjacent circular pumping shaft caisson sunk into the ground that will soon be connected as the Brunel Museum extension. (See Mathewson et al. (2006).) The Brunel Museum applied for and obtained £120,000 from Association Independent Museum (AIM), and is fundraising to match the grant to expand. Robert Hulse, Director of the Brunel Museum, showed drawings of the plans for a new gallery, performance space and museum entrance inside the caisson and then

took the ASCE civil engineers inside the pumping shaft. Afterwards, the three couples walked for lunch to the nearby Mayflower Pub [initially named the Shippe], the oldest pub on the River Thames). A century later the Shippe was rebuilt and renamed the Spreadingeagle & Crown. In 1957 the pub was restored as the Mayflower Pub. The Mayflower ship was built at Rotherhite and launched in the spring of 1620 with Captain Christopher Jones (Rotherhite man) for the new World via Southampton and Plymouth, England, and so on to America where pilgrims celebrated with the first Thanksgiving. Inside the Mayflower Pub is a list of those sailing on the 1620 Mayflower and a plaque for the Tunnel Club. Related to the Brunel Museum- London, from Wikipedia: The "SS *Great Eastern* was an iron sailing steam ship designed by I. K. Brunel, and built by J. Scott Russell & Co. at Millwall on the River Thames. She was by far the largest ship ever built at the time of her 1858 launch, and had the capacity to carry 4,000 passengers from England to Australia without refueling."

Next, the ASCE group took the London Tube to the Westminster Station next to Parliament. The three couples walked along Great George Street past Westminster Abbey to the Institution of Civil Engineers (ICE) Building at One Great George Street. ICE was founded by young civil engineers in 1818, wanting a professional civil engineering society, led by Henry Robinson Palmer. The young ICE founders invited the respected, famous civil engineer Thomas Telford to be the first ICE President in 1820. Telford accepted the Presidency, donating his personal books to start an ICE library, useful to young engineers and ICE members. (See Ferguson and Chrimes (2011).) At the present ICE library, Mike Chrimes met the ASCE group and displayed several historical civil engineering books on the Tower Bridge design and construction. Then, Mike Chrimes took the three couples into the Great ICE Halls to view oil paintings and where ICE hosts various U.K. meetings and large events. Afterwards, the EWRI group visited Westminster Abbey. (In 2013, the Institution of Civil Engineers (ICE) London presented "Engineering the London Underground," celebrating the illustrious 150- year history of London's Tube network and the vital role that civil engineers played in delivering one of the world's first and busiest transport networks.)

YORK

On the next morning, Aug. 15, the three couples took a taxi to the renovated Kings Cross Railway Station, a major railroad terminus, opened in 1852 on the northern edge of central London. In 2005, a £500 million restoration plan included a thorough restoration and reglazing of the arched roof of the original station. A new semi-circular departures concourse opened to the public on 19 March 2012. Nearby, the central London St. Pancras railway station, opened in 1868, has been renovated, and renamed St. Pancras International since 2007 for Eurostar trains to Europe. When it first opened, the arched Barlow train shed was the largest single-span roof in the world. The three couples boarded a train to York. At York, two couples toured the National Railway Museum (NRM), a collection of over 100 locomotives and nearly 300 other items of rolling stock, on the 20 acres (8.1 ha), in three big exhibit halls, including the famous Flying Scotsman. One couple booked a York hotel to spend time in the famous York Minster Cathedral. After the NRM, the four others boarded a York train to Edinburgh, packed with fans from the Scotland vs. England soccer match.

EDINBURGH (See Paxton and Shipway, 2007.)

The two couples arrived at Edinburgh Waverley Station and caught a bus to Heriot - Watt University where they spent the next three nights. That evening, Professor Roland Paxton

showed the two couples the Institution of Civil Engineers - Scotland Museum and displayed several historical engineering books and items, including a rare Kirkwood engraved map of early Edinburgh. On Friday, the third couple arrived at Heriot - Watt University via train and bus. On Aug. 16, the three couples plus ASCE 2012 President Andrew Herrmann and wife enjoyed the Edinburgh Military Tattoo at Edinburgh Castle. There has been a fortress on the Castle rock for hundreds of years. Royal apartments were built at Edinburgh Castle, forming the nucleus of the later palace block, and a Great Hall was in existence by 1458. In 1464, access to the castle was improved when the current approach road up the north-east side of the rock was created to allow easier movement of the royal artillery train in and out of the area now known as the Upper Ward. The Military Tattoo, begun in 1950, is a 90-minute program of U.K. and international military precision marching bands and units that begins at sunsets in August each year.

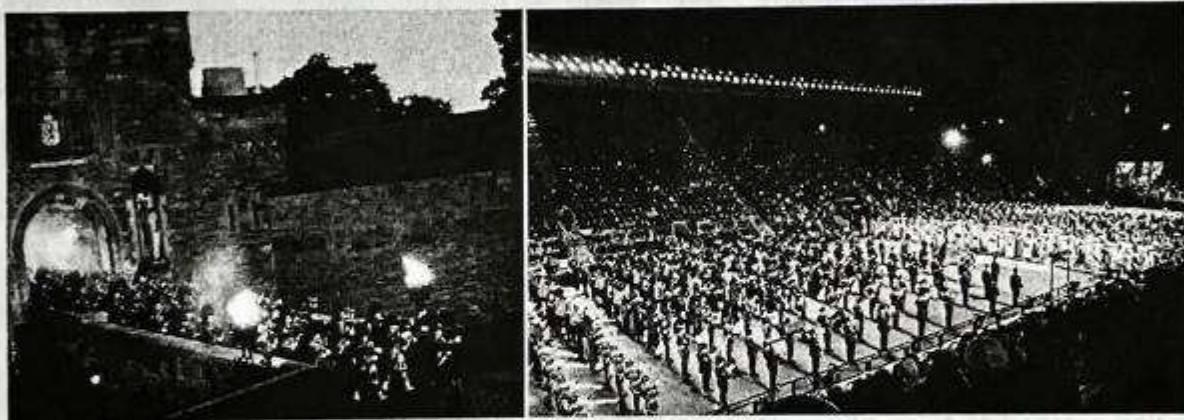


Figure 3. and Figure 4. Photos of Aug. 16, 2014 Edinburgh Military Tattoo near Edinburgh Castle by and with permission from A.J. Fredrich.

On Aug. 17, the four ASCE couples attended a symphony concert in Usher Hall at the 2013 Edinburgh International Festival.

ARBROATH

On Sunday Aug. 18, the EWRI group took the train from Edinburgh Waverley Station past St. Andrews historic golf course and Dundee to Arbroath. The train passed over the 1890 Firth of Forth Rail cantilever bridge (designed by John Fowler and Benjamin Baker with construction by William Arrol and others), the first International Historic Civil Engineering Landmark with a plaque dedication in 1985 by ASCE and the Institution of Civil Engineers. The Forth Bridge opened on 4 March 1890 and spans a total length of 8,296 feet (2,528.7 m). Until 1917, when the Quebec Bridge was completed, the Forth Bridge had the longest balanced cantilever bridge span in the world. In 2015, the Forth Rail Bridge will celebrate its 125th Anniversary of the 1890 opening. (After the collapse of the first Tay Bridge, the major bridges of the time in the United

Kingdom, the second Tay, Forth and Tower Bridges, were built by William Arrol company.)

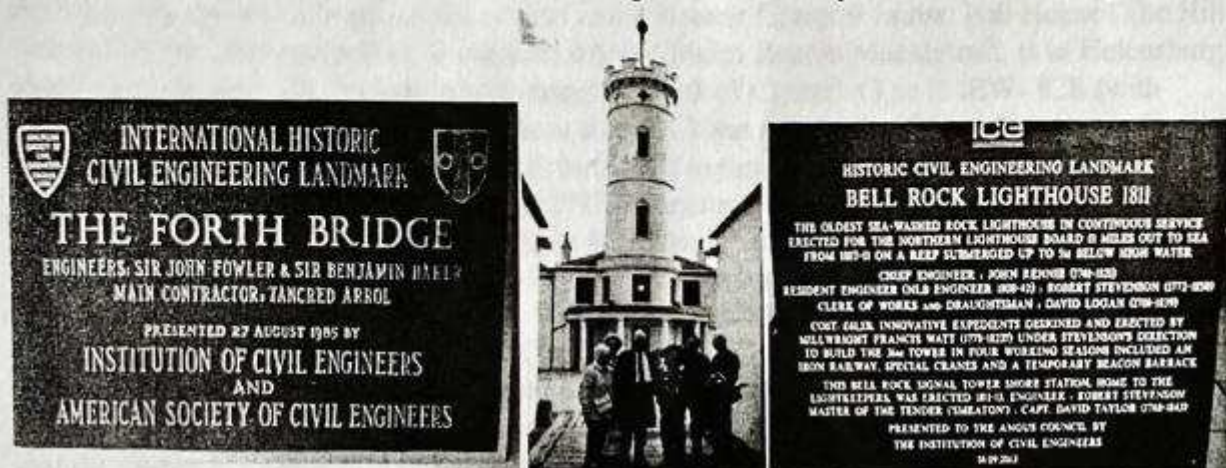


Figure 5. IHCEL photo (Permission Figures 6, 7. EWRI group photo: Bellrock Lighthouse from Roland Paxton for his photo). Tower Museum (A.J. Fredrich; permission, Website)

The Bell Rock Lighthouse, off the coast of Angus, Scotland, is the world's oldest surviving sea-washed lighthouse. It was built between 1807 and 1810 by civil engineers John Rennie and Robert Stevenson on the Bell Rock, 11 miles (18 km) west of the Firth of Tay. With a height of 35 meters (115 ft), its light is visible from 35 statute miles (56 km) inland. The masonry work on which the lighthouse rests was constructed to such a high standard that it has not been replaced or adapted in 200 years. The lamps and reflectors were replaced in 1843. The lighthouse has been automated since 1988. The lighthouse operated in tandem with a shore station, the Bell Rock Signal Tower, built in 1813 at the mouth of Arbroath harbor. This building houses the Signal Tower Museum, a visitor center detailing the history of the lighthouse. David Taylor, who runs the Bellrock website: www.bellrock.org.uk/, met the EWRI group at the rail station and all walked to the Old Boatyard Restaurant for lunch before walking to the Signal Tower Museum. After going to the top of the Signal Tower Museum, David took the EWRI group to the Arbroath Abbey. Arbroath's history as a town had begun in the High Middle Ages with the founding of Arbroath Abbey in 1178 by King William the Lion for monks of the Tironensian order from Kelso Abbey. It received consecration in 1197 with a dedication to Saint Thomas Becket. It was the King's only personal foundation, and he was buried within its precincts in 1214. Arbroath grew considerably during the Industrial Revolution owing to the expansion of the flax and the jute industries and the engineering sector. A new harbor was built in 1839, and by the 20th century Arbroath had become one of the larger fishing ports in Scotland. After the Abbey, the EWRI group said goodbye to David Taylor and took the train back over the Firth of Forth rail bridge to Edinburgh Waverley and a bus on to their Heriot - Watt University lodging.

GLASGOW (See Paxton and Shipway (2007), Paxton (2013) and Rogers (2013).)

On Monday Aug. 19, the three EWRI couples caught a train from Waverly to Glasgow Central with a taxi to the Erskine Bridge Hotel where the ICE history committee (Panel on Historic Engineering Works) met and stayed the next two nights. On Monday afternoon, many ICE, PHEW, ASME, IMech E and ASCE/EWRI people toured the Auchentoshan Distillery with some scotch whisky sampling. On Monday evening at the Clydebank (West Dunbartonshire Council) town hall, Professor Roland Paxton presented the career story: "Adam Hunter (1869-1933) - 'Engineer Extraordinaire'" (with William Arrol's firm), the designer of the Titan Crane and

erector of four London bridges. On August 19, there was a PHEW Annual General Meeting at the hotel or a spouses tour of Loch Lomond and a historic Glasgow home: Hill House (The Hill House, built in 1904 by famous Scottish architect Charles Rennie Mackintosh, is in Helensburgh, about 40 miles west of Glasgow, overlooking the Firth of Clyde.) (The PHEW- ICE (with geographic representatives from throughout the U.K.) was formed in 1968, a few years after the ASCE History and Heritage Committee (now HHC) began in 1964 with the assistance of the National Park Service and ASCE.) At the PHEW meeting, Chair Brian Crossley passed the leadership to Gordon Masterton who was an ICE Past President. On Tuesday afternoon, a large group of attendees attended the Titan Crane plaque ceremony for the International Historic Civil and Mechanical Engineering Landmark. ASCE President 2012 Andrew Herrmann represented ASCE with the President of ICE Barry Clarke and ASME and IMechE Presidents participating. During the great shipbuilding and locomotive building days of the Clydebank industries, the Titan Crane built some of the largest ships afloat operating world-wide, including the *Aquitania* and the *Queen Elizabeth I, II* and *Queen Mary*.



Figure 8. Photo of International Historic Civil and Mechanical Engineering Landmark photo with permission by Roland Paxton, Jerry Rogers, Kathlie Bulloch.

Figure 9. Refurbished Titan Crane with elevator (with permission):
www.titanclydebank.com

Next, the attendees toured the relatively new Titan Crane Visitor Center and took the elevator to the top of the crane for spectacular views of the Clyde River, Clydebank and Glasgow. There also was a scenic boat ride along the Clyde River next to the Titan Crane. Afterwards, we visited the Forth & Clyde Canal (built 1768-1790) at Bowling with the IHCEL presented in 2000 at the ICE Millennium Conference in Edinburgh. Provost Douglas McAllister hosted a nice dinner in the Clydebank (West Dunbartonshire Council) town hall, where there were historic exhibits of the town and port history and Singer (sewing machine) and other industries nearby. Jerry Rogers was asked to make a slide presentation on: "U.K. International Landmark Plaques with some Scotch Whisky Highlights," compiled with assistance from the good HHC website (www.asce.org, click on People and Projects to search landmarks) with International and National HCEs. On Aug. 21, the PHEW (with the EWRI/ASCE couples) visited the largest UK masonry railway arch, Ballochmyle Viaduct (1846-48), a seven-arch engineering masterpiece. (The Glasgow & South Western Railway (1850), Chief Engineer John Miller, had a landmark plaque unveiled on 25 April 2014.) Next, the tour stopped at the Dick Institute, Kilmarnock, where an ICE National HCE plaque (Kilmarnock & Troon Railway (1812), Scotland's first public railway, Chief Engineer: William Jessop, was presented by Roland Paxton to Provost Jim Todd, East Ayrshire Council, for mounting in the Dick Institute.



Figure 10. August 21, 2013 Photo of PHEW/ASCE Group outside the Dick Institute-Scotland from and with permission: cheryl.paton@east-ayrshire.gov.uk

After saying farewells, two couples caught an express bus from Glasgow to the Edinburgh Airport for flights, ending the U.K. portion of a memorable historic engineering visit to London, York, Edinburgh, Arbroath and Glasgow.

ACKNOWLEDGEMENTS

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REFERENCES

- Ferguson, Hugh and Mike Chrimes, 2001. The Civil Engineers: The Story of the Institution of Civil Engineers and the People Who Made It, ICE - T. Telford. ISBN 978- 0-7277- 4143- 1.
- Mathewson, Andrew, Derek Laval, Julia Elton, Eric Kentley, Robert Hulse, 2006. The Brunels' Tunnel, ICE-The Brunel Museum, ICE - T. Telford. Paperbound ISBN: 978-0-9504-3612-8.
- Paxton, Roland and Jim Shipway, 2007. Civil Engineering Heritage Scotland: The Lowlands and Borders, 396 pp. ICE - T. Telford. Paperbound ISBN: 978-0-7277-3487-7.
- Paxton, Roland and Jim Shipway, 2007. Civil Engineering Heritage Scotland: Highlands and Islands, 272 pp. ICE - T. Telford. Paperbound ISBN: 978-0-7277-3488-4.
- Paxton, Roland, 2013. "Adam Hunter (1869-1933)-'Engineer Extraordinaire,'" POWERPOINT, presented 19 August at Clydebank Town Hall to ICE, IMechE, ASCE, and ASME Visitors.
- Rogers, Jerry. 2013. "United Kingdom: International Historic Civil Engineering Landmark Plaques (1993 – 2013) with Some Scotch Whisky Highlights," 19 pp. (revised: 8/4/13) Unpublished paper for ICE, PHEW, ASCE, and Titan Crane plaque ceremonies/dinner.
- Smith, Denis, 2001. Civil Engineering Heritage: London and the Thames Valley, ICE -Telford. Paperbound ISBN: 978-0-7277-2876-0.