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Managing the inner world of infrastructure

M. Abbott
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, No. 1, February, 26–32
doi: 10.1680/cien.2007.160.1.26

Stakeholder participation in major infrastructure projects is a multi-faceted and controversial topic. This paper introduces some of the more immediate issues and attempts to show that experience in so-called first-world projects is equally relevant in the third world. It suggests that every project exists in an 'outer' physical world and an 'inner' world of the collective minds of stakeholders, and that the creation of a communications environment in which the two worlds can begin to align is essential to success. This is now increasingly possible thanks to the internet and mobile telephony and, as demonstrated by experiences on the £6 billion Denmark–Sweden fixed link, it can lead to an almost utopian working environment of complete trust and absolute integrity.

St Katharine Docks, London—Telford's high-speed harbour

M. Chrimes
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, Special Issue 1–81
Thomas Telford: 250 years of inspiration, May, 48–55
doi: 10.1680/cien.2007.160.5.48

The current paper describes Thomas Telford's work as engineer for St Katharine Docks, London, in the context of his role as a maritime engineer. Although not the largest in London, they presented one of the most challenging projects in Telford's career, not least owing to the extreme time pressure he was put under to get the docks trading in London's then busy and profitable shipping industry. With up to 1000 construction workers on site, and despite a major flood, the first ship entered the dock in 1828—just three years after contracts were let.

Channel Tunnel Rail Link section 2: Thames tunnel

M. Burgess and H. Davies
Proceedings of the Institution of Civil Engineers, Civil Engineering, **160**, Special Issue 2—Channel Tunnel Rail Link section 2, November, 14–18
doi: 10.1680/cien.2007.160.6.14

Tunnelling under the Thames estuary was considered to be the greatest risk to section 2 of the Channel Tunnel Rail Link project—now known as High Speed 1. However, it was delivered safely and ahead of programme by the application of risk management and sound engineering by the tunnel-boring machine manufacturer and contractors. This paper describes the award-winning design and construction of the 3·6 km long, twin-bore crossing.

Modelling corrosion initiation of steel in concrete

C. P. Atkins, L. J. Buckley, A. R. Foster and P. Lambert
Proceedings of the Institution of Civil Engineers, Construction Materials, **160**, No. 2, May, 81–85
doi: 10.1680/coma.2007.160.2.81

The main cause of corrosion initiation in steel reinforcement within concrete is the presence of chlorides above a threshold value. The primary source of chlorides is from the external environment, either from marine structures or de-icing salts. The most commonly used method of predicting or modelling chloride ingress is to use Fick's second law. Inevitably, there are significant variations involved in the positioning of the steel, the exposure conditions surrounding the concrete and the concrete itself. Due to the variability in chloride penetration and cover it is commonly found that the data will suggest that somewhere on the structure, chlorides have reached the depth of the steel. A single reinforcement bar with very low cover is, however, simple to address. It is more relevant to know when a significant proportion of the reinforcement is likely to become exposed to higher chloride concentrations. As structures are required to last for longer periods, and existing structures are reused for new purposes, the prediction of the likelihood of corrosion becomes more and more important. This paper presents two methodologies that may be applied to obtain a statistical assessment of chloride penetration from site data.

Durability of silica fume and ggbs concrete in a tidal zone

E. Ganjian and H. S. Pouya
Proceedings of the Institution of Civil Engineers, Construction Materials, **160**, No. 3, August, 103–111
doi: 10.1680/coma.2007.160.3.103

This paper summarises investigations that were conducted to assess the durability of plain and blended type II Portland cement exposed to marine tidal environments. In this research the performance of cement paste and concrete mixes incorporating 7 and 10% silica fume as a cement replacement was investigated in three exposure conditions with seven days' initial curing in potable water. The performance of plain and blended cements was evaluated by monitoring changes in compressive strength and capillary absorption. The results show that plain type II Portland cement performed better than blended silica fume cement under cyclic wetting and drying conditions. Silica fume specimens under cyclic wetting and drying conditions in simulated seawater exhibited higher strength loss in comparison with plain type II Portland cement when cured under potable water. In addition, the greater the silica fume amount used in the mixes, the more the capillary water absorption under tidal zone exposure and/or under wetting and drying simulation. Further, the ternary-blended ground granulated blast-furnace slag mix was the worst-performing mix in all exposure conditions. An extended initial curing time is recommended for these types of mixes.

Making reinforced concrete immune from chloride corrosion

G. K. Glass, B. Reddy and L. A. Clark
Proceedings of the Institution of Civil Engineers, Construction Materials, **160**, No. 4, November, 155–164
doi: 10.1680/coma.2007.160.4.155

Chloride-induced corrosion is a major factor affecting the durability of reinforced-concrete structures. However, a high tolerance to chloride contamination has often been achieved under laboratory conditions. A significant factor affecting the chloride threshold level for corrosion initiation in concrete is the presence of defects, such as air voids, in the cement paste at the steel–concrete interface. To explain this observation it is noted that corrosion initiation and propagation involve the local production of acid at sites where the steel passive film breaks down in the otherwise highly alkaline concrete environment. Thus, solids with pH-dependent dissolution behaviour affect the corrosion process. Solid phase corrosion inhibitors would release hydroxyl ions to prevent this local reduction in pH. By reducing the entrapped air-void content at the steel to values below 0.2% it was possible to increase the chloride threshold level from 0.2% to above 2% chloride by weight of cement as the voids no longer dilute the inhibitive solid phases. A high tolerance to chloride contamination may also be achieved by reducing the electrolyte content of voids and by using electrochemical treatments to generate a reservoir of hydroxide-containing salts at the steel–concrete interface. Chloride contamination at levels above 2% chloride by weight of cement at a reasonable steel cover depth may not be possible in concrete exposed to many environments when the concentrating effects of evaporation are minimised. Thus, a chloride threshold level of 2% may effectively render steel immune to chloride-induced corrosion.

North Hoyle offshore wind farm: design and build

J. M. F. Carter
Proceedings of the Institution of Civil Engineers, Energy, **160**, No. 1, February, 21–29
doi: 10.1680/ener.2007.160.1.21

North Hoyle is the UK's first major offshore wind farm. It comprises 30 wind turbine generators each capable of generating up to 2MW. The total installed capacity is therefore 60MW and enough electricity is generated each year for some 40 000 homes. The wind farm offsets an annual release of about 160 000 tonnes of carbon dioxide. Initial site investigations began in the summer of 1999 and by April 2001 a Development Licence was awarded by Crown Estate and the Department for Trade and Industry (DTI). Public consultation commenced in July 2001 and the Consent Application was submitted in February 2002. All the required consents were granted by October 2002. Following a competitive bidding process, a design and build contract was awarded to the North Hoyle Consortium (comprising Vestas Celtic Wind Turbines and Mayflower Energy) in the autumn of 2002. Onshore construction commenced in November 2002 with offshore construction commencing in April 2003. First official generation from the site was in mid November 2003 and the wind farm was fully operational in April 2004. Total project costs were around £80 million.

European Marine Energy Centre: facilities and resources

J. Norris and I. Bryden
Proceedings of the Institution of Civil Engineers, Energy, **160**, No. 2, May, 51–58
doi: 10.1680/ener.2007.160.2.51

This paper describes the European Marine Energy Centre (EMEC) wave and tidal test facility, which was established on Orkney Islands, UK, to assist and hasten the development of the wave and tidal stream energy conversion industries. The facilities include infrastructure and a number of soft provisions, or services. After a brief overview of the theory of wave and tidal energy assessment and extraction, the wave and tidal resources available at the EMEC test sites are summarised. The paper also gives an update on the uptake of facilities by developers.

Energy generation from a Severn Barrage prior to full commissioning

M. J. Watson and T. L. Shaw
Proceedings of the Institution of Civil Engineers, Engineering Sustainability, **160**, No. 1, March, 35–39
doi: 10.1680/ensu.2007.160.1.35

The Severn Estuary provides the UK with a unique opportunity to harness a large amount of renewable energy from the tides. A barrage 10 miles (16 km) long has been proposed as a means of harnessing this energy. The scheme would be similar, but on a larger scale, to that in the Rance Estuary, northern France, which has consistently and predictably produced electricity over the last 40 years. The studies presented here illustrate the output patterns of the Severn Barrage once the barrage is closed but before project completion, taking into consideration important factors such as: National Grid integration; environmental sensitivities and turbine and pumping characteristics. Assuming the main determinand of operating

procedure is production of maximum energy, total barrage output could be 33 TWh by project completion. This is equivalent to almost two years of output from the completed scheme. Furthermore, if barrage closure were to occur earlier than previously envisaged, significantly more electricity would be produced during the construction phase, thus further enhancing the project's economic prospects.

Optimising flow—sediment transport parameters for rivers

G. Akbari
Proceedings of the Institution of Civil Engineers, Water Management, **160**, No. 3, September, 153–158
doi: 10.1680/wama.2007.160.3.153

The unsteady flow–sediment transport equations for a real river–reservoir system contain unknown hydraulic, sediment and geometric parameters. Knowledge of these parameters and input data comprising initial and boundary conditions is required to simulate flow–sediment transport, water surface and river bed profiles. The sensitivity analysis and optimisation procedure, which involves determining these parameters by fitting a model with real river field data, is an important tool for finding the best-fit values of each parameter in a river–reservoir sediment transport model. Sensitivity analysis and optimisation methods have been found to be very useful when applied to sediment routeing problems in river–reservoir systems. This technique was employed for optimisation of some of the important parameters involved in graded sediment routeing and bed armouring processes using a non-linear coupled model (NCMG). The particular parameters studied in this investigation are degradation, bed armouring and grain size distribution of bed material in a river bed downstream of a dam. The effects of bed roughness, sediment parameters and thickness of the active layer on bed level changes are studied. A combined Gauss–Newton and modified Newton method are employed to calculate optimized parameters.

Scour in hydraulic engineering

W. H. Hager
Proceedings of the Institution of Civil Engineers, Water Management, **160**, No. 3, September, 159–168
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As a result of damage and failures due to undermining of foundations and the blockage of water flow caused by sediment aggradation downstream of scour holes, scour in hydraulic engineering has become an important issue in recent decades. This paper presents recent research on: (*a*) plunge pool scour in which a variety of effects were investigated; (*b*) bridge piers for which spatial and temporal scour development was described using particle image velocimetry for a test case; (*c*) the failure of riprap-protected spur dykes in a straight river reach. In all three fields, the main features of scour are described based on similitude according to Froude—that is, using the densimetric Froude number of the approach flow as the dominant parameter. The large number of parameters involved were controlled with suitable experimental setups allowing for the determination of the governing effects of a scour problem. Results are presented that readily apply to river engineering problems.

Local scour by submerged offset jets

R. Karki, M. A. A. Faruque and R. Balachandar
Proceedings of the Institution of Civil Engineers, Water Management, **160**, No. 3, September, 169–179
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In this paper an effort is made to understand the scour caused by submerged offset jets impinging on a cohesionless sand bed. A square cross-section nozzle and a two-dimensional (2D) nozzle spanning the width of the flume were used to generate the jets. The 2D offset jet experiments were conducted at two values of the densimetric Froude number ($F_0 = 5{\cdot}5$ and 10) and two receiving water depths corresponding to shallow and deep tailwater conditions. The square offset jet tests were conducted at $F_0 = 10$ and correspond to deep tailwater conditions. Velocity measurements were conducted using a laser Doppler anemometer. For both jet types, at a given densimetric Froude number, progressing from the start of the test towards asymptotic conditions, the geometric parameters used to describe scour were found to be sensitive to the offset distance. Offset refers to the vertical distance between the nozzle invert and the initial sand bed and an asymptotic state refers to the situation where no significant change in the scour geometry was noticed with increasing time. For the 2D zero-offset jet condition, a backward-facing step was formed at the invert of the nozzle and the general flow features resembled those of an offset jet. At the lower value of the relative tailwater depth, the flow and the corresponding scour pattern was different from that found at the deep tailwater condition. For the square jet, the shape of the scour hole and the corresponding mound were elongated longitudinally and decreased laterally as the offset distance was increased. The distance between the nozzle and the point of the beginning of the scour hole was found to increase with increasing offset distance. Turbulent bursts were noted to occur and to influence the scour process. By proper choice of scaling variables, the centreline scour profiles in the hole region were collapsed onto a single curve.

A simple method for estimating flood flow around bridges

G. Seckin, T. Haktanir and D. W. Knight
Proceedings of the Institution of Civil Engineers, Water Management, **160**, No. 4, December, 195–202
doi: 10.1680/wama.2007.160.4.195

The software program HEC-RAS from the Hydrologic Engineering Center (HEC) of the US Army Corps of Engineers is probably one of the most commonly used methods in the world for computing water surface profiles in rivers. The energy method (one of the four bridge subroutines within HEC-RAS) computes the bridge backwater (the upstream surface increase) by applying standard step calculations five times from the end of the expansion reach up to the beginning of the contraction reach, using two different transition loss coefficients and different reach lengths. The aim of this study was to estimate the backwater in a less cumbersome and practical way, without sacrificing accuracy. A one-step energy method is suggested, based on a comprehensive set of laboratory bridge backwater data from compound channels. The proposed method gives an absolute mean error of 10% when applied to these laboratory data and an absolute mean error of 25% when applied to field data collected by the United States Geological Survey including actual flood profiles through many bridges.

Experiments on stilling basins for dam outlets

A. Goel

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A series of experiments was performed with the aim of developing shorter and more efficient stilling basins for dam outlets (in comparison with Garde's stilling basin), keeping the floor of the basin at the invert level (lowest level of outlet) of the outlet. The experiments were conducted for a pipe outlet diameter $d = 58$ mm, inflow Froude number $Fr = 3{\cdot}44$ and basin lengths of $12d$, $10d$, $8d$ and $7d$. New models were developed by conducting systematic experimentation on stilling basin models using different types of appurtenances such as wedge-shaped blocks, a grid, an intermediate sill and an end step. It was found that the newly developed stilling basin models are not only shorter in length but also show superior performance in terms of maximum depth of scour and its location when compared to Garde's model.