

## Elsewhere in *ICE Proceedings*

S. K. Fullalove, *Editor*

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### **Seismic design of Egnatia Motorway bridges, Greece**

K. Ahmadi-Kashani

*Proceedings of the Institution of Civil Engineers—Bridge Engineering*,  
**157**, No. 2, June, 83–91

Egnatia Motorway in Greece is currently one of the largest civil engineering projects in Europe with over 600 bridges on its main axis alone. With the motorway traversing a wide range of seismically active terrains, a variety of bridge forms with different earthquake protection systems are constructed or planned on this project. This paper provides general information on Egnatia Motorway bridges and describes the technical requirements for their seismic design. Measures taken to resist potential seismic forces are outlined for a few major bridges, and computer software developed for seismic hazard risk assessment of the bridges on this project is described.

### **Re-using urban foundations**

T. Chapman, T. Butcher and R. Fernie

*Proceedings of the Institution of Civil Engineers—Civil Engineering*,  
**157**, No. 1, February, 6

Continuing redevelopment of the world's cities is getting more difficult as the earth beneath them fills up with foundations and tunnels. Tim Chapman of Arup, Tony Butcher of BRE and Rab Fernie of Cementation report on an EU-funded research programme that aims to encourage re-use of existing foundations.

### **Artificial intelligence v. equations**

G. N. Pande and H.-S. Shin

*Proceedings of the Institution of Civil Engineers—Civil Engineering*,  
**157**, No. 1, February, 39–42

Artificial neural networks are increasingly being used by mathematicians and scientists for complex calculations but apparently not by civil engineers. Such networks have many advantages over rigid equations and design codes, not least that they can be continually 'retrained' when new field or research data become available. On the downside, like people, they are not very transparent and not always reliable. This paper shows how a relatively simple neural network can outperform Burland and Burbidge's well-established 1985 ground settlement equation. The advantages and disadvantages of the technique are also discussed.

### **Cement: reducing pressure on the green belt**

A. Bromage

*Proceedings of the Institution of Civil Engineers—Civil Engineering*,  
**157**, No. 2, May, 57

The UK Government's target to build over two million new homes on brownfield land by 2016 looks ambitious given the amount of contamination. Alan Bromage, head of civil engineering at The Concrete Centre, says greater use of cement could be the answer to saving the green belt.

### **Boston's massive jacked tunnels set new benchmark**

A. Powderham, C. Howe, A. Caserta, D. Allenby and J. Ropkins

*Proceedings of the Institution of Civil Engineers—Civil Engineering*,  
**157**, No. 2, May, 70–78

British tunnel-jacking expertise contributed to savings of over US\$300 million on the vast project to build Boston's new subterranean highway network. The change from traditional cut-and-cover construction to tunnel jacking in frozen ground enabled three full-size interstate highway tunnels—totalling over 240 m in length—to be built in heavily obstructed ground under the approaches to a busy railway station with no disruption to service. The scale of the work was unprecedented, being several times larger than any tunnel-jacking project previously undertaken. It has set a new benchmark for the technique and further raised its profile as an effective and sustainable solution for creating new urban infrastructure.

### **Earthquake-proof house shakes bamboo world**

L. Jayanetti and P. Follett

*Proceedings of the Institution of Civil Engineers—Civil Engineering*, **157**, No. 3, August, 102

Over 1 billion people already live in houses made from bamboo, the fastest-growing woody plant on the planet. Lionel Jayanetti and Paul Follett of Trada say there is significant further potential for bamboo as a strong and sustainable building material, particularly after the success of a recent full-scale earthquake test.

### **Electrokinetic geosynthetics: getting the most out of mud**

C. Jones

*Proceedings of the Institution of Civil Engineers—Civil Engineering*, **157**, No. 3, August, 103

An innovative drainage and ground consolidation technology has been developed in the UK involving electrified ground reinforcement. Colin Jones, emeritus geotechnical professor of the University of Newcastle Upon Tyne and past president of the International Geosynthetics Society, introduces his invention of electrokinetic geosynthetics.

### **Observational method looks set to cut city building costs**

T. Chapman and G. Green

*Proceedings of the Institution of Civil Engineers—Civil Engineering*, **157**, No. 3, August, 125–133

Construction of a new 20 m deep commercial building basement in the centre of London involved what is believed to be the first true application of the 'observational method' on a major building project. Use of the ground movement monitoring technique, previously confined to civil engineering projects, allowed the top-down construction sequence on this confined urban site to miss a floor. This made it easier to remove the large concrete base of an existing basement and cut 20 weeks off the construction programme. All observed ground movements were within preset limits, so contingency measures were not needed, resulting in a highly cost-effective solution that could have wide application in the building sector.

### **New station brings trains back to Auckland's centre**

M. Maylin and S. Shanmuganathan

*Proceedings of the Institution of Civil Engineers—Civil Engineering*, **157**, No. 4, November, 164–171

With a population of just 3.7 million, New Zealand is not exactly renowned for its traffic problems. However the economy of Auckland, its largest city, was starting to suffer from the global bane of traffic congestion and something had to be done. The first step towards a more integrated transport system was to return the main railway station back to the city centre site it vacated 65 years ago, only this time underground. By combining conventional materials with state-of-the-art design and construction methods, the project team was able to deliver a large, safe and attractive transport interchange within a very limited budget and time frame.

### **Channelling research funding into civil engineering**

B. Clarke and T. Bracegirdle

*Proceedings of the Institution of Civil Engineers—Civil Engineering*, **157**, No. 4, November, 179–186

The major problems the world faces—ranging from energy, water and food supplies to poverty, primary resource depletion and terrorism—are the key drivers to the European Union's publicly funded research programmes. For civil engineers, however, it is research into business processes, materials, design and construction technologies that is needed if they are to remain competitive and able to adapt to change. As this paper explains, attracting research funding means promoting the direct benefits of the profession to society and showing how research will enhance and extend those benefits.

### **Construction of tyre-shreds test embankment**

R. Salgado and M. Prezzi

*Proceedings of the Institution of Civil Engineers—Engineering Sustainability*, **157**, No. 2, June, 65–66

In view of the vast numbers of used tyres stockpiled across the USA and their problematic disposal characteristics, it makes environmental and financial sense to find ways of recycling them. This briefing paper describes a research project which was undertaken in Indiana to construct and test a soil-tyre embankment. Findings are outlined and recommendations made.

### **The recycling and alternative uses of marine sediments**

N. J. Cooper

*Proceedings of the Institution of Civil Engineers—Engineering Sustainability*, **157**, No. 3, September, 123–130

The theme of this special issue, the reuse of materials, can apply to: (a) the recycling of marine sediments from areas of natural deposition to replenish denuded frontages elsewhere; or (b) the alternative uses of otherwise waste material derived from navigation dredging activities. Such material reuse in the marine environment can provide environmental benefits, assist in reducing risks from tidal flooding or coastal erosion if used in foreshore recharge schemes, or cost-effectively provide construction resources. This paper considers drivers behind reuse of materials in the marine environment, identifies the opportunities and constraints to its application, and discusses key sustainability aspects of these approaches, such as economic, social and environmental issues. Example case studies are provided of two alternative use schemes and one sediment recycling scheme, highlighting both the practical benefits and the practical complexities of these approaches, depending on the specific situations in which they are set.

### **Geotechnical aspects of sewage sludge monofills**

B. C. O'Kelly

*Proceedings of the Institution of Civil Engineers—Municipal Engineer*, **157**, No. 3, September, 193–197

More stringent controls on the quality of wastewater discharges are giving rise to increasing volumes of sewage sludge for disposal. Within the European Community, the disposal of sewage sludge to sea ceased by 1998 under the Urban Wastewater Treatment Directive. Stricter waste disposal

legislation and higher landfill taxes are forcing the water industry to look for more efficient disposal strategies. Dedicated sludge-to-landfill operations are presented as a viable option. The sewage sludge is dewatered to the optimum water content for compaction, placed in the landfill in layers and compacted to the maximum dry density, thereby maximising the operational life of the landfill site. The design, construction and long-term performance of such monofills are described. Adequate levels of dewatering for the sludge-to-landfill route can best be achieved at the treatment plant using conventional mechanical dewatering devices, sludge drying beds or thermal drying processes.

#### **Bringing brownfield sites back into use**

T. Carey

*Proceedings of the Institution of Civil Engineers—Municipal Engineer*, **157**, No. 4, December, 231–237

To meet Government targets for the building of infrastructure and new homes, particularly in London and the South East, redundant brownfield sites will need to be rapidly brought into use. This paper describes the challenges surrounding these aspirations, specifically the problems that accompany brownfield developments. These are outlined by reference to specific building projects undertaken by St George during its 17 years of developing in London, on brownfield sites. The paper also describes the company's areas of research and concludes by making recommendations for the future.

#### **Strength of steel fibre reinforced concrete ground slabs**

S. Chen

*Proceedings of the Institution of Civil Engineers—Structures and Buildings*, **157**, No. 2, April, 157–163

Tests are reported on four full-scale concrete ground slabs. Two types of steel fibre have been used to reinforce the concrete, with fibre contents of 20 and 30 kg/m<sup>3</sup>, which is lower than the minimum recommended in the Chinese construction practice. It is found that flexural toughness has an effect on the load-carrying capacity of steel fibre reinforced concrete (SFRC) ground slabs. The ultimate load capacity of the ground slabs is assessed and compared with the test results from different sources. The load-carrying capacity of the SFRC ground floors with flexural toughness effect is assessed. The horizontal thrust induced by the friction between the slab and the subgrade is also analysed.

#### **Fundamental tests of reinforced concrete columns subjected to seismic strength loading**

S. Sinha and L. Roy

*Proceedings of the Institution of Civil Engineers—Structures and Buildings*, **157**, No. 3, June, 185–199

Past experimental research studies on the strength and ductility capacity of structures showed that the ductility capacity is strongly affected by loading condition. For repeated loading such as earthquake motion, the design based on the strength and ductility factor alone is not always reasonable, and the energy absorption capacity of structures is a better index for evaluating seismic safety. This study quantitatively investigates the energy absorption capacity of reinforced concrete (RC) column subassemblies. Five RC columns were tested under four

types of repeated loading. Once the energy absorption capacity is calculated, the structural safety under strong earthquake motion may be judged by the comparison between the energy imparted to the structure by earthquakes and the energy absorption capacity of the structure.

#### **Earthquake loading of high-strength concrete walls**

H.-D. Yun, C.-S. Choi and L.-H. Lee

*Proceedings of the Institution of Civil Engineers—Structures and Buildings*, **157**, No. 3, June, 201–209

Observations of an experimental research programme on the response of high-strength concrete structural walls under cyclic loading have been presented in the companion paper. In the present paper, a subsequent analysis has been carried out in order to assess the contribution of deformation components—that is, flexural, diagonal shear, and sliding shear on total displacement. The results from the analysis are then utilised to evaluate the prevailing inelastic deformation mode in each of the walls. Moment–curvature characteristics, ductility and damage index are quantified and discussed in relation to both axial stress levels and the amount of web reinforcement. Consequently, the implications of both experimental and analytical studies on the seismic design of high-strength concrete walls are discussed.

#### **Permissible-stress design of ground-floor slabs**

A. A. Abbas, M. N. Pavlovic and M. D. Kotsovos

*Proceedings of the Institution of Civil Engineers—Structures and Buildings*, **157**, No. 6, December, 369–384

The analysis and design of ground-floor slabs has traditionally been based on maximum principal tensile stresses computed in accordance with elastic principles, despite the growing trend to apply plastic methods in design. Existing elastic guidelines stem from approximations derived nearly a century ago and their reappraisal is long overdue. In the present paper, an updated set of design equations—which, for practical purposes, may be said to be 'exact'—is presented and is shown to be more efficient than current plastic methods. These new rules appear to show considerable savings over current design guidelines when permissible stress is the governing criterion.

#### **A philosophy for a performance specification for road foundations**

C. D. F. Rogers, P. R. Fleming and M. W. Frost

*Proceedings of the Institution of Civil Engineers—Transport*, **157**, No. 3, August, 143–151

The road foundation layers perform several functions both during construction and when the road is in service, for example load-spreading, temporary haul routes, and a base for the overlying construction layers. The critical loading condition is usually directing trafficking where the applied stresses are greatest. The capping and sub-base layers during construction require adequate stiffness and strength to resist these stresses. The current UK specification for road foundations is based on a recipe approach, and, unless permission is granted to use an analytical design, the pavement foundation designs are based entirely on the California Bearing Ratio (CBR) to characterise the subgrade, capping and sub-base materials. Here CBR is used as an index of both material

strength and stiffness, although it measures neither directly. Such an approach is potentially inefficient and does not readily facilitate the use of new and marginal materials or alternative design procedures. Recent technical advances in laboratory and *in situ* testing of pavement foundation materials now allow the performance parameters of stiffness, strength and resistance to permanent deformation to be measured both for design and during construction. This in turn enables a performance-based specification for road foundation layers to be introduced to provide some assurance of the as-constructed quality, and by permitting the use of secondary or recycled aggregates, to contribute to the parallel goal of sustainable construction. This paper sets out an idealised philosophy for a performance-based specification for road foundations, examines the individual elements of the specification in relation to current knowledge and makes recommendations for a phased introduction alongside CBR-based methods.

### **Accelerated pavement testing in highway engineering**

S. F. Brown

*Proceedings of the Institution of Civil Engineers—Transport*, **157**, No. 3, August, 173–180

Full-scale accelerated testing of pavements has become a powerful technique for assisting with understanding pavement deterioration under realistic conditions and measuring pavement response to moving wheel loads. It forms an essential bridge between laboratory work and theory and the site situation. In the USA there has been a major investment in such facilities in recent years following a careful assessment of the potential cost–benefit ratios. Extensive experience in South Africa suggests a ratio of about 1:10, and this would be the likely situation in the UK if further investment were made. A description is given of the leading test tracks and testing machines, focusing mainly on US developments but with reference to experience in the EU and elsewhere. Equipment that is laboratory-based, such as that at the Transport Research Laboratory in the UK, and facilities that may be moved to various sites are reviewed. It is concluded that a mobile facility that uses the best of modern technology blended with proven experience from elsewhere would be most appropriate to support the UK highway industry in the future.

### **King's Cross underground station, London: an overview**

G. T. Bessant

*Proceedings of the Institution of Civil Engineers—Transport*, **157**, No. 4, November, 211–220

King's Cross St Pancras underground station is one of the busiest underground stations in London. It has a current daily morning peak of 55 000 passengers, is served by five underground lines and two National Rail stations, and will receive passengers from the European continent when the Channel Tunnel Rail Link is complete. In addition it is sited at the junction of major roads, and its existing buildings date from the 1860s. This paper describes the history of the station, the constraints of building a new station round operating railways in the heart of the metropolis, the means of achieving increased passenger capacity and improved passenger flows, the extent of service diversions, and the consequent design solutions.

### **King's Cross underground station, London: geotechnical aspects**

S. R. Macklin and H. C. Yeow

*Proceedings of the Institution of Civil Engineers—Transport*, **157**, No. 4, November, 221–229

The redevelopment of London Underground's King's Cross St Pancras Station in central London is being carried out to increase capacity from the current 55 000 passengers per hour during the morning peak to an anticipated 82 000, following the construction of the adjacent Channel Tunnel Rail Link (CTRL) terminus. The work will be undertaken in two phases: phase I works, currently nearing completion, which comprises a new western ticket hall and upgrade of the existing tube ticket hall; and phase II, which will comprise a new northern ticket hall and tunnelled links between the existing underground stations. This paper reviews the considerable amount of geotechnical work carried out for the project and will focus principally on three key areas: (a) developing an understanding of the potential hazards related to the stratigraphy of the site; (b) the use of advanced numerical methods; and (c) the role of instrumentation and monitoring within the design and risk management process.

### **Simple modelling of dam failure in a natural river**

F. Macchione and G. Viggiani

*Proceedings of the Institution of Civil Engineers—Water Management*, **157**, No. 1, March, 53–60

The complex problem of dam failure and subsequent flood estimation is considered. Numerical models are required and distinctive features of natural rivers such as friction and real topography have to be considered. When treating regions of rapidly varied flow, shock-capturing methods are useful and the Saint-Venant equations, in conservative form, should be employed. A number of explicit second-order two-step schemes exist, such as the 'upwind schemes'. They require non-linear limiters, such as 'total variation diminishing' limiters (TVD), to prevent numerical oscillations. 'High resolution schemes' are obtained and complex routines have to be implemented. Run time can be burdensome even for one-dimensional calculations. Thus, in this article a very easy to implement scheme, the diffusive scheme, is considered. Stability and accuracy of the numerical solution are analysed and the performances in terms of water depths are tested. The Malpasset dam-break case (France, 1959) is referred to as a test case. Numerical results are compared with the depth measurements of a physical model and with the results of two other numerical models available in the literature.

### **Performance of flood embankments in England and Wales**

M. Dyer

*Proceedings of the Institution of Civil Engineers—Water Management*, **157**, No. 4, December, 179–188

There are some 35 000 km of estuarine and river flood defence embankments in England and Wales with an annual budget of approximately £450million spent on maintenance and new construction. The effective performance of these embankments during extreme flood events is critical for the provision of sustainable flood defences. However flood embankments can

become less effective over a period of time for a number of reasons such as (a) increased frequency of flooding due to climate change, (b) an increase in the required standard of service or other functional requirements and (c) long-term deterioration from the intended condition—as constructed or maintained. The tendency for earth embankments to deteriorate with time is of particular concern because climate change and the increasing rate of occurrence of extreme events are leading

to an increase in loading. This paper reviews the geotechnical factors that can affect the performance of fluvial and estuarine flood defence embankments in the short and long term. The review considers the traditional methods used to construct flood embankments compared with modern techniques, the type of local materials used for construction, the range of possible geotechnical factors that can lead to a loss of performance and finally case histories of embankment breaches.