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Michèle Dix interview p18

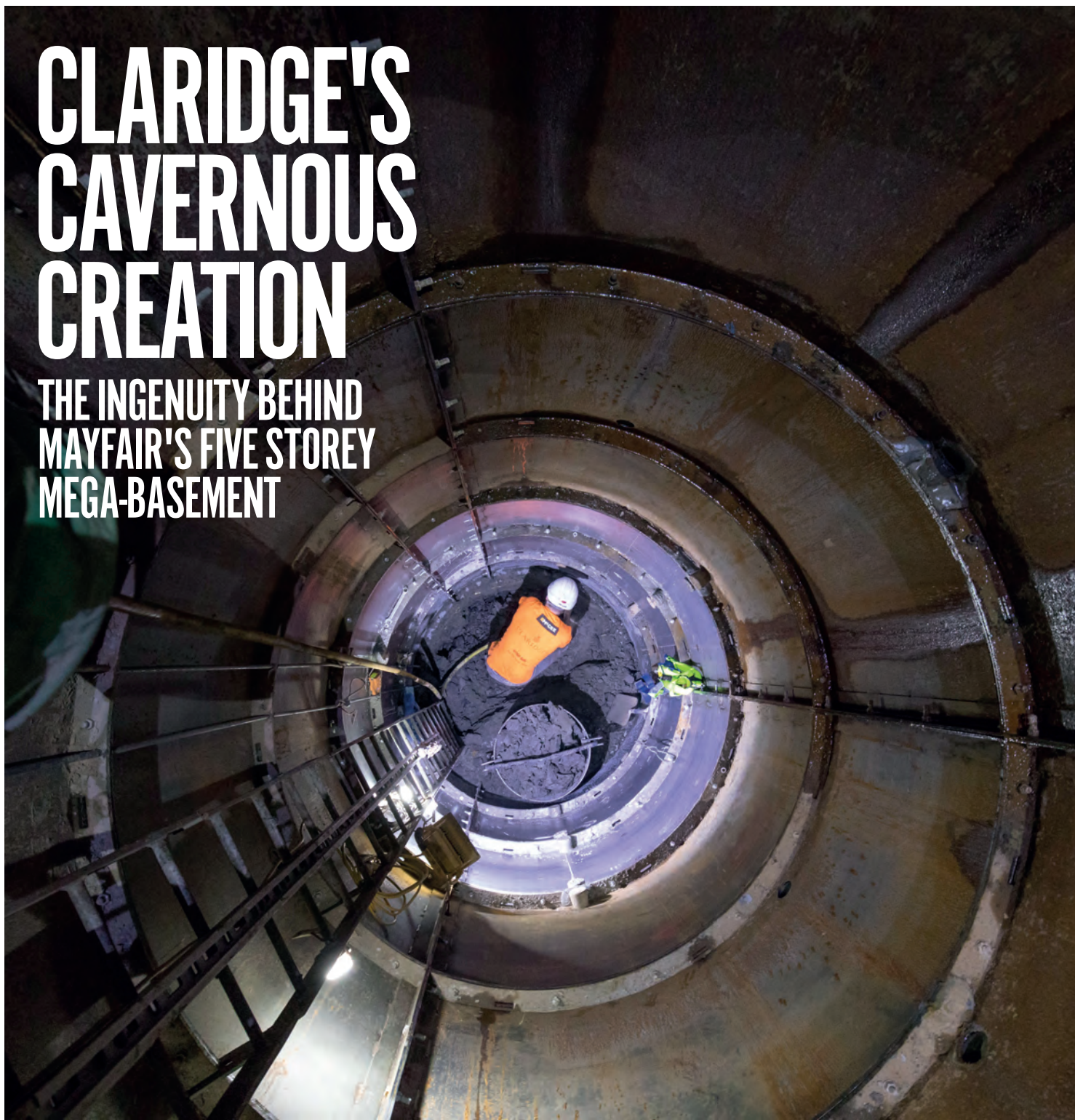
Future of rail p27

New Civil Engineer

AUGUST 2019

CLARIDGE'S CAVERNOUS CREATION

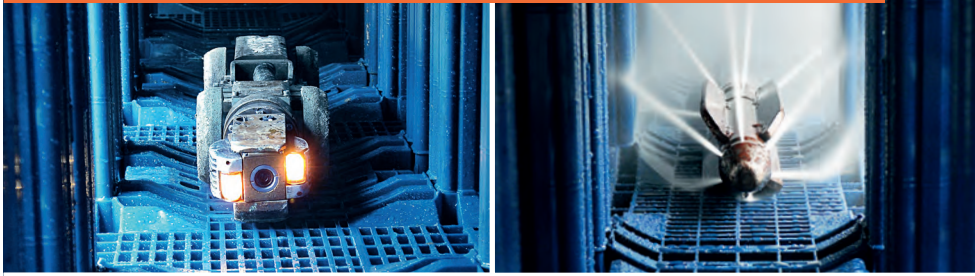
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MARK HANSFORD

EDITOR



his month's issue looks to the future of rail; arguably chosen because rail in the present day is pretty grim. As *New Civil Engineer's* Future of Rail conference in June revealed (and as we report in the magazine this month), workloads from the biggest client Network

Rail are being kept deliberately under wraps; major projects such as High Speed 2 (HS2) are stuck going nowhere; major initiatives such as Northern Powerhouse Rail remain in their infancy and broadly unfunded; and recent big spenders such as Transport for London have run out of money.

Much is made of attracting private investment via market-led proposals, but even here there is no clarity from government about what kind of proposals might be deemed acceptable in the new private finance initiative-free era.

It genuinely is an extraordinary time for the rail industry.

Network Rail's latest five year control period (CP6) has been underway since April and yet, as we reveal this month, transport secretary Chris Grayling is blocking publication of its preferred enhancements pipeline, which would detail the £2bn of new projects it intends to deliver. The industry is genuinely clamouring for this information as it is the only new project work that is guaranteed to be widely available over the next five years, as the bulk of CP6's £35bn spending is focused on maintenance and renewals and £8bn of the £10.1bn enhancements pot set aside to complete projects that spilled over from the last control period.

That £8bn of the £10.1bn enhancements pot is already spoken for is almost entirely down to the industry's major project under-delivery in CP5, largely on electrification projects. So to some degree, it would be a bit rich of the industry to start crying foul.

And there remain near-record levels of overall investment going into rail – even before the government's current HS2 commitment is taken into account.

Rail minister Andrew Jones certainly unsold on the need to share the pipeline. He challenged delegates at the Future of Rail conference, saying: "Do most industries have a guaranteed marketplace of several billions of pounds a year? So come on, start getting with the pro-

gramme of being positive," he asserted.

It is a fair point, but equally it could be argued that punishing the industry for electrification failings by withholding vital information about prospective work will only set in motion a perpetual circle of inefficient delivery. The electrification programme failed for many reasons but a generally-agreed critical factor was the absence of skills and experience in the industry, given it had been such a long time since the last major programme. Equally it is largely agreed that consistency of workload is key to the civil engineering sector's efforts to overcome its productivity issues.

“Punishing the industry for electrification failings by withholding vital information about prospective work will only set in motion a perpetual circle of inefficient delivery”

There are probably broader political reasons why the list has yet to be published. It is more than likely that a new transport secretary could be in place before very long and priorities may change. Once again infrastructure is probably being used as a political football, and once again we are reminded of why there is so much desire for the National Infrastructure Commission to be put on some sort of statutory footing.

But it isn't and probably won't ever be. So for now the message to Grayling and Jones – or whoever may replace them in the coming days and weeks – has to be: publish the list, and give the industry some of the certainty it craves to prove that it can deliver efficiently and productively. And maybe, just maybe, get this control period's projects delivered in this control period. Wouldn't that be good?

● Mark Hansford is *New Civil Engineer's* editor

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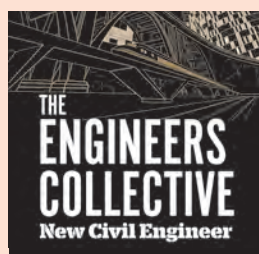
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New Civil Engineer's latest podcast tackles the future of rail with HS2 Ltd strategic technical adviser

Andrew McNaughton

newcivilengineer.com/podcast

WITH THIS ISSUE

Thameslink Programme major project report:
Delivering better cross London rail services



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Putting passengers first is the secret of rail reform

Rail networks in the UK. When they work, they work. When they don't, they become headline news. To some extent, this highlights the significant dependence people have on the UK's rail networks, a positive legacy on which to build.

Despite the momentary setbacks, rail travel has seen a surge in demand over the last 20 years with journey numbers having more than doubled since 1997.

The flipside is that the UK's rail fares remain the highest in Europe.

Several reviews by various governments have been commissioned to look into the fare challenge, including the 2011 McNulty review.

It identified the positives of passenger growth, improvements in safety, high levels of investment and new infrastructure. Despite this, the review said, there had been "a significant increase in the total cost of the industry to government and to end users."

That cost to users, through year-on-year ticket price increases; and to the public, through taxes, is significant. So, when things go

“When things go wrong, passengers feel aggrieved



BY ART WE
MASTER
WHAT WOULD
MASTER US

wrong, passengers feel aggrieved – and the newspaper headlines return. But how do you solve a problem like GB rail?

That was the task given to Keith Williams in another review announced in September 2018, this time a full-scale independent review into the running of Britain's railways.

At the time, issues with timetabling and delays to infrastructure programmes had left passengers questioning the service they were receiving. Equally those within the rail sector could spot opportunities for improvements as well.

The ICE's submission to the Williams' review focused on the need to view rail as, ultimately, an infrastructure system.

Its starting point was its National Needs Assessment (NNA), a comprehensive look at the drivers of future demand across economic infrastructure sectors.

The NNA recommended that the government increase investment in the commuter rail network to ensure the economic development of urban centres is not constrained by overcrowding and congestion.

The NNA also highlighted the fact that substantive funding for transport should be devolved to local and regional authorities to allow them to invest in the growth of their economies.

It said that electrification of the rail network must take place, and be done at pace, in order to meet carbon reduction targets.

“Project 13 aligns closely with the Williams Review's aim to put passengers first

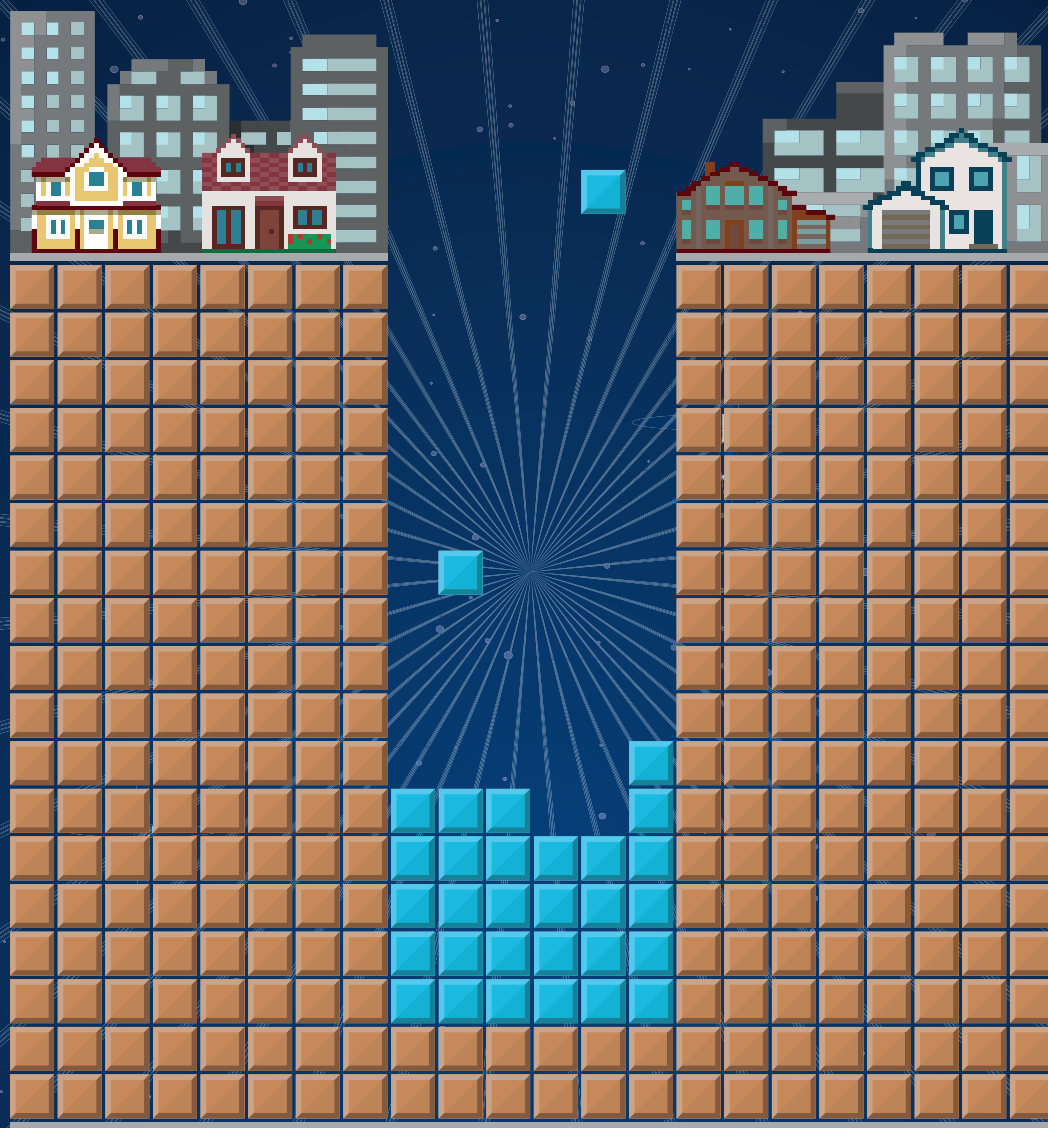
The ICE's submission to the review also emphasised the role of Project 13 in project and programme delivery. An industry-wide change programme to move the industry from a transactional business model to an enterprise model, Project 13 offers a unique opportunity to marshal the entire industry around clearly defined outcomes.

In November 2018, Network Rail became a Project 13 “early adopter”, committing to implement the principles into its next generation track alliances. Project 13 aligns closely with the Williams Review's aim to put passengers first, as it focuses the organisation on customer outcomes first and foremost.

As part of the early adopter scheme, Network Rail will also learn from and share good practice with other infrastructure organisations to further improve outcomes.

An integrated approach will ultimately lead to a more resilient and better-value railway for passengers and industry – which is surely something we can all agree will deliver the best future.

● **Comments about the Lighthouse Column to policy@ice.org.uk**



GAME CHANGER

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The Edit

THE BIGGEST STORIES OF THE MONTH
FROM NEWCIVILENGINEER.COM



HS2 project promoter ramps up the use of gagging orders on contractors and consultants

HIGH SPEED 2

More than 100 contractors, consultants and public bodies were asked to sign secretive non-disclosure agreements (NDAs) with High Speed 2 promoter HS2 Ltd in 2018, *New Civil Engineer* can reveal. Details of a Freedom of Information (FoI) request to HS2 Ltd revealed that the £56bn project's promoter had signed a total of 280 NDAs with "external parties" between 2012 and March this year, with 40% of those signed in 2018 alone. Often referred to as "gagging orders", an NDA is a legal agreement between two parties to prevent the disclosure of secret information or to keep trade secrets confidential. The FoI request revealed that four NDAs – also known as confidentiality agreements – were signed in 2012 and 2013. This increased to 10 in 2014, 27

in 2015, 34 in 2016 before doubling to 71 in 2017 as procurement of the main civils contracts concluded. The figure rose to 112 in 2018. HS2 Ltd also asked 18 external parties to sign NDAs between January and March this year.

“The project's promoter had signed a total of 280 NDAs with “external parties” between 2012 and March this year

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BUSINESS

KIER CUTS 1,200 JOBS AS IT SEEKS COST CUTS AND REVENUE GROWTH

Kier plans to cut 1,200 jobs as the troubled contractor seeks to make cost savings. The firm has completed a strategic review under new chief executive Andrew Davies. This has identified ways to reduce debt and generate revenue. It is understood that 650 full-time employees will have left the firm by the end of July. Kier chief executive Andrew Davies said: "These actions are focused on resetting the operational structure of Kier, simplifying the portfolio, and emphasising cash generation in order to structurally reduce debt. By making these changes, we will reinforce the foundations from which our core activities can flourish in the future."

STRUCTURES

HAMMERSMITH BRIDGE CAR BAN COULD BECOME PERMANENT

Hammersmith Bridge could remain permanently closed to motorists, a senior Transport for London (TfL) director has revealed. Speaking at *New Civil Engineer's* Future of Roads conference, TfL director of project & programme delivery Nick Fairholme revealed that TfL is working on three options for the bridge with Hammersmith & Fulham Council. The bridge has been closed for almost three months, after hairline fractures in cast iron "pedestals" were discovered. The first option would be to carry out no repairs and leave the bridge as a cycling and pedestrian crossing. The second would be to carry out a partial repair and restrict the bridge's weight limit to single-decker buses and local traffic. The third option would be to carry out a full repair, although Fairholme said that would be "very expensive". *New Civil Engineer* understands that a full repair could be as much as £100M with work estimated to take around three years.

KEY STATS

112
Number of High Speed 2 non-disclosure agreements signed in 2018



TRANSPORT

NEW THAMES CROSSING

Thames Clippers and marine engineering consultants Beckett Rankine have released images of the proposed Rotherhithe ferry crossing of the Thames which Transport for London (TfL) is now considering after the cost of a proposed bridge to Canary Wharf soared to \$600M. TfL scrapped the bridge plans and is now assessing the proposed electric, self-docking, self-charging ferry.

TRANSPORT

TURNER & TOWNSEND TO MANAGE AUSTRALIAN RAIL MEGA-PROJECT

Consultant Turner & Townsend has been named programme manager for Australia's biggest ever rail project. Appointed by the Australian Rail Track Corporation, Turner & Townsend will oversee governance processes and support decision-making for the A\$10bn (\$5.6bn), 1,700km Inland Rail project to connect Melbourne in the southern state of Victoria north to Brisbane in Queensland.

TRANSPORT

PLANS FOR 'CARDIFF CROSSRAIL' PUBLISHED BY COUNCIL

Cardiff Council has published plans for a new light rail project for the city dubbed "Cardiff Crossrail". The 22km light rail line, would connect major population centres in the east and west with the city centre with the central railway station. Cardiff Council also wants to create a new "Cardiff Circle line" to connect other population centres in the north west to the Coryton and City light rail lines.

TRANSPORT

GOVERNMENT WILL HAVE TO FIND CASH TO FUND STONEHENGE TUNNEL

Highways England chief executive Jim O'Sullivan has said the government will have fund all of the £1.7bn Stonehenge tunnel rather than bringing in private finance. Speaking at *New Civil Engineer's* Future of Roads Conference, O'Sullivan said there was "no time" to find another funding model for A303 to be delivered on time, and that public funding is now the only viable option.

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Inside Track

THE BIGGEST ISSUES OF THE MONTH EXPLORED



CARBON REDUCTION

Net Zero rules to hit infrastructure pipeline

Road, rail and energy projects will have to ensure that they comply with new, stricter carbon emission rules

BY CONNOR IBBETSON AND ROB HORGAN

Plans for dozens of the UK's biggest infrastructure projects will have to be redrafted to meet new, stricter carbon emissions rules.

A *New Civil Engineer* investigation has revealed that Heathrow's third runway, the Lower Thames Crossing and the Sizewell C nuclear plant are among dozens of planned projects whose plans will have to be redrafted to comply with new net zero regulations.

Prime minister Theresa May announced in June that the Climate Change Act 2008 was to be updated with an amendment to reflect recommendations laid out in the Committee on Climate Change (CCC) *Net Zero* report.

The updated legislation commits the UK to cutting carbon emissions by 100% to a net zero level by 2050. The bill that will bring the net zero goal into law is currently awaiting a second reading in the House of Commons.

The changes to the law are likely to affect all development consent orders (DCOs) which are currently sitting at the pre-examination or pre-approval

stage. DCOs are handled by the Planning Inspectorate and are required for large-scale projects which are deemed to be of "national interest".

There are currently 64 applications which are at the pre-examination or pre-approval stage, 19 of which are road projects, six relate to rail works, while 27 are energy projects.

The remaining projects include two interconnector cables as well as the Gatwick and Heathrow airport expansion projects.

A Planning Inspectorate spokesperson told *New Civil Engineer* that any DCO application "will need to take account of the specific legal and policy requirements

in place at the point of application.

"There is an obligation on applicants to have regard to and adhere with relevant legislation, policy and guidance including (where applicable) the UK Government's commitments to tackling climate change."

DCOs are categorised by region, with 14 projects currently at a pre-examination or pre-approval stage in the UK's Eastern region, 13 in the South East and nine in the North East.

Law firm Pinsent Masons head of infrastructure planning Robbie Owen told *New Civil Engineer* that while climate change is not a new issue for developers, they will have to keep up with specific changes affecting their projects.

Owen said that the need to redraft plans will depend on the stage of each individual DCO application, the lifespan of the asset and the relevant National Policy Statement.

"Climate change is not a new issue, this has been the case for the past 10 years [in terms of planning]," said Owen. "Law and policy changes happen all the time and this is another example of how developers will need to adhere to them."

Highways England has the largest number of DCO applications at the pre-examination stage, with 18 projects potentially needing to be redrafted to meet the new regulations.

Among them is the £6.8bn Lower Thames Crossing, the new M54 to M6 link road, and several upgrades to the A1.

A Highways England spokesperson said it was closely monitoring changes to the Climate Change Act.

"An update to our current assessment method is scheduled to be published shortly and in the meantime all of our projects will need to continue to consider legislative changes and the implications on the project."

Integral parts of Heathrow Airport Ltd's (HAL's) expansion masterplan may also have to be torn up and redrafted if the proposed changes to the UK's climate change legislation are passed.

Documents published by HAL show that calculations of carbon impact for the planned expansion have been worked out using current rules which require the UK to cut carbon emissions by 80% by 2050.

A climate impact report published

64

Projects which could be affected by new law

by HAL as part of its masterplan states: “The assessment presented in this [report] does not explicitly seek to reflect recommendations from the CCC Net Zero report in terms of potential changes to current and future carbon budgets.”

A number of environment and planning lawyers and consultants have told *New Civil Engineer* that if the new goals become law, HAL could be forced to redraft parts of its expansion masterplan including construction work and surface access. (More on Heathrow’s expansion plans on page 14.)

It is understood that plans for carbon capture and storage could be added to the masterplan to fall in line with the stricter standards, a source told *New Civil Engineer*.

Alternatively, more efficient aircraft propulsion, airspace management and alternative fuels could increase efficiency by approximately 40%. Mott MacDonald group strategic development manager Simon Harrison said adapting to a net zero climate was the biggest peace time challenge the industry has faced.

Mott MacDonald – along with Skanska, Anglian Water, National Grid, University College London and the ICE – have established a zero-carbon coalition to help guide the industry.

BuroHappold has also written an open letter dubbed “Structural Engineers Declare” to the government declaring a “climate and biodiversity emergency”. All engineering firms are being urged to pledge their support by signing the letter.

Harrison told *New Civil Engineer* that it is difficult to know where to focus efforts without better guidance from the government.

“What [Net Zero] points to are challenges of great scale and urgency not normally seen in peacetime, a normal response is not going to be sufficient to meet these challenges,” Harrison said. “What this really will need is innovation and greater clarity in terms of policy so the industry can invest in the future.”

WSP UK director of sustainability David Symons said the industry must think ahead about how projects designed today will operate in a zero-carbon world.

“The government doesn’t have all the answers, but our codes and practices tend to be slower than the pace of change,” he said. “So we as an industry must move fast and be at the heart of this change because there is so much opportunity to lead it.”

HIGH SPEED 2

Old Oak Common rows

Court battle delays start of west London station scheme

BY ROB HORGAN AND KATHERINE SMALE

Old Oak Common is fast becoming a battleground for High Speed 2 (HS2) challengers.

A High Court challenge over the £1bn High Speed 2 station contract has come amid calls for the Euston section of HS2 to be kicked into the long grass in the upcoming government Spending Review.

Pressure has been mounting for the line to be terminated at Old Oak Common. The price tag to build the new HS2 part of Euston Station totals £1.65bn, and the main contract to build the tunnels between Old Oak and Euston are budgeted at \$740M.

In January, the then HS2 Ltd chair Terry Morgan called for the first phase of the project to terminate temporarily at Old Oak Common rather than at Euston in a bid to cut costs.

Speaking at the *New Civil Engineer* Future of Rail conference Old Oak Common architect Wilkinson Eyre director Bosco Lam said it could be possible to terminate trains at the West London hub. The current plans have trains stopping at Old Oak Common before terminating at Euston Station in central London.

Supporters of an Old Oak Common terminus proposal will have more time to make their case as station construction will not begin until September at the very earliest. Work has been delayed after a judge dismissed HS2 Ltd’s request to hear its application for lifting the automatic suspension placed on the contract before the court’s summer recess.

HS2 Ltd had been hoping that the court ruling which is preventing work starting on the west London hub, would be lifted this month.

The automatic suspension was placed on the contract after Bechtel lodged a legal challenge in February claiming that HS2 Ltd accepted an “abnormally low bid” when it awarded its £1bn contract for Old Oak Common construction partner contract to a joint venture between Balfour Beatty Group, Vinci Construction and Systra (BBVS).

HS2 Ltd’s official defence document



submitted to the court denies “each and every allegation” in Bechtel’s claim. In particular it says that there is no basis for identifying BBVS’ tender as abnormally low.

Speaking before the Technology & Construction Court, HS2 Ltd’s legal representative Sarah Hannaford QC said that it was “a matter of urgency” that the suspension is lifted.

BBVS legal representative Anneliese Blackwood also complained that failing to lift the suspension would negatively impact her clients as terms set out in the Old Oak Common station contract reward contractors for completing work ahead of schedule, while fines are imposed if an already agreed completion date is not met.

However, High Court judge Mr Justice Fraser dismissed the request for a hearing before the summer recess and criticised HS2 Ltd for taking “a third of a year” to submit an application to have the contract suspension lifted.

“While I accept that drawing out this process could delay the project, there has already been a delay between 22 February [when Bechtel submitted its appeal] and 1 July [when HS2 Ltd sub-

Old Oak Common:
Battleground



mitted its application for the suspension to be lifted],” he said.

“Therefore it is hard to accept the argument that it is a ‘matter of urgency’.”

In summary, Justice Fraser concluded that there was “insufficient time” for Bechtel’s legal team to prepare for a hearing before the end of July.

Instead, a hearing on HS2 Ltd’s application to lift the suspension has been set for September 3. BBVS has also been granted permission to submit evidence and was expected to do so before July 12.

Justice Fraser also set a date of 5 October 2020 for a full court hearing to determine if Bechtel is owed damages in relation to HS2 Ltd’s procurement process.

£1bn

Value of Old Oak
Common station
construction contract

STRUCTURES

Collapse criticism

Contractors ‘failed to spot
Florida collapse warning signs’

BY KATHERINE SMALE

Failures by the consultant, contractor, construction engineer and inspector are highlighted in an official report into last year’s fatal Florida bridge collapse.

The report published by the United States Occupational Safety and Health Administration (OSHA) says that consultant Figg Bridge Engineers, which was acting as the engineer of record, violated Florida Department of Transport safety requirements and failed to recognise that the Florida International University (FIU) bridge was in danger of collapsing despite growing cracks.

The post-tensioned concrete trussed bridge, which was under construction, collapsed onto a live eight lane road in March last year, killing six people and permanently disabling another (*New Civil Engineer* May 2018).

The report states that on inspection of the numerous “deep and wide structural cracks” the road beneath the bridge should have been closed to traffic immediately.

“Figg Bridge Engineers, the Engineer of Record, failed to recognise that the bridge was in danger of collapsing when it inspected it hours before the collapse,” the report concludes. “The concrete truss had developed numerous wide and deep structural cracks jeopardizing the integrity of the bridge.”

“The engineer of record should have immediately instructed that the bridge be shored at appropriate locations and SW 8th Street be closed.”

The report states that on the morning of the incident, Figg held a meeting with project participants after evaluating the cracks over the previous two days.

At that meeting, the report reveals that a Figg engineer acknowledged that his computations could not replicate the cracks and so he did not know why the cracks were occurring. Despite admissions that the cracks were growing in size, the Figg engineer stated “more than once” that the cracks did not pres-

ent any safety concerns.

At the time of the collapse, work to re-tension bars in one of the diagonal members at the north end of the bridge was being carried out. The report concludes that these works were not included in the original design and therefore should have been subject to peer review.

The report also reveals that an independent check on the design of the bridge had only been carried out for the completed design and not during the different construction stages.

In its final conclusion the report states that the engineer of record should have known that the truss was a non-redundant structure and that if one diagonal member failed, the entire bridge could collapse. Given this, it says that the necessary safety precautions should have included closing the roadway below the bridge and propping until a complete evaluation was carried out.

In response Figg branded the report “flawed, incomplete and inaccurate” saying it failed to include factors leading up to the accident.

“The OSHA FIU Pedestrian Bridge report is factually inaccurate and incomplete, and includes errors and flawed analyses,” a Figg spokesperson said. “It does not include an evaluation of many important factors pertinent to the construction process leading up to the accident.

“Additionally, it has not been reviewed by any other entities involved in the accident investigation. Figg disagrees with the conclusions in the OSHA report.”



The bridge collapsed onto a busy road

Heathrow expansion plans are ready for take off

**Emily Ashwell
and Sam Sholli**



he engineers undertaking the expansion of Heathrow Airport are under pressure from all angles.

The site, 25km west of central London, is constrained by two major motorways, industry, housing and rivers, which means there is currently no room for a new 3.5km runway.

The plan for the airport's expansion, which would increase capacity from the current 78M passengers per year to around 142M in 2050, has vocal and powerful opponents, including MPs, residents and environmental lobby groups.

LAG, which owns British Airways and whose customers will help pay for the scheme, has described the £14bn price tag as a "con", claiming the airport seems "hell bent" on ramping up costs. Heathrow maintains the third runway project, which includes M25 diversion work, will cost £14bn and the total £30bn cost is for the whole masterplan development.

And, critically for a profession which is working to rebuild public confidence after the failure of Crossrail to open to time and budget, it must live up to the project delivery benchmark set by former BAA chief executive Sir John Egan and others with the construction of Terminal 5 (T5).

KEY STATS

78M
Number of
passengers
Heathrow
handles per
year

142M
Annual
Number of
passengers
Heathrow
expects to be
handling by
2050

So, a decade on from the 2008 opening of T5, how does Heathrow Airport plan to build its third runway and can it pull off another engineering masterstroke?

As it launched its latest consultation on its expansion plan last month, Heathrow Airport published what is the most comprehensive guide to programme yet.

Expansion director Phil Wilbraham told *New Civil Engineer*: "The key thing from an engineering perspective is threefold: one [aspect] is to ensure that it's enabled by digital. It is really important to us that a digital twin is created so we can test it all before we actually construct it.

"We are also really keen for as much manufacturing to be done offsite as possible. Therefore we're going to create our four logistics hubs around the country to be close to the factories where parts of the development can be manufactured. Thirdly, we want to assemble onsite, as opposed to construct.

"What that means is ultimately we

**“Most of the
trade work
is done in factories
and the assembly
takes place on the
construction site**



want to avoid hot works or wet works on-site, so that most of the trade work is done in factories and the assembly takes place on the construction site."

Delivery of the new runway situated in the north west corner of the existing airport will be a civil engineering job on an epic scale, including diverting the M25 motorway 130m west and diverting local rivers underneath the new runway.

The new 14-lane road tunnel directly under the runway will be made up of four boxes – two for the new M25 main carriageways and one each for the northbound and southbound distributor roads.

The motorway will be lowered by around 5m, so the runway level ties in with the existing airport. This, combined with the rest of the runway development, would see more than 20M.m³ earth removed.

Onsite concrete batching plants and precasting areas will be established to minimise the transportation of ready-mix concrete by road.

A new railhead will be constructed



“We are asking the industry to consider how they will develop their businesses based on Project 13 principles

to bring materials to site.

The existing M25 will remain open until the construction of the diversion is complete.

“What it means is we can build that new section offline from the motorway. We would not be able to lower the motorway on the existing line because we could not shut the motorway,” adds Wilbraham.

Approaching the airport clockwise from the south, Junctions 14 and 14a which serve terminals 4, 5 and the cargo area, will be altered.

“Our plans currently show a revised junction 14 and 14a. They will serve similarly as they do today. Junction 14 will serve terminal 4 and cargo, but also serve the car parking complex on the south-west border [of the airport]”

“Junction 14a will serve T5 and Terminal 5X, which will be the new terminal just to the west of the existing T5,” he adds.

In addition, there will be local road diversions and upgrades to the A4, the A3044 and Southern

The M25 will be diverted and taken under the new runway in tunnel

Perimeter Road including work on existing junctions and the construction of a southern road tunnel from the Beacon Road junction on the Southern Perimeter Road to a new Central Terminal Area.

In terms of river reconfiguration, the Colne Brook will be diverted around the western end of the new runway.

A special covered river corridor will be built to channel the diverted Colne and Wraysbury River, Duke of Northumberland’s River and Longford River under the runway.

With the new runway comes new passenger terminal buildings, which will be based on an eco-design including low carbon energy generation.

There will be a massive reconfiguration of terminals, which will ultimately result in the expansion of T5, and the construction of a new terminal called Terminal 5X and an apron. Terminal 5X will feature a public transport interchange.

A new Central Terminal Area will be created from Terminals 2 and 3, with

new satellite terminals created within that area as well as another new public transport interchange.

During the later stages of construction, Terminal 3 will be demolished to make way for new aircraft stands, Terminal 1 will also be demolished and Terminal 4 will be modified.

So how can the project delivery team live up to the legacy of T5? Here, it is turning to the ICE’s Project 13 scheme, which aims to transform relationships between clients, contractors and designers. Heathrow is an early adopter of the scheme, aiming to become what Project 13 describes as a “capable client” – the area of Project 13 that Wilbraham, working with Manchester Business School, has defined.

Project 13 is a blueprint for project roles and relationships, aiming to get the industry to operate on a more collaborative, long-term basis to become more productive and innovative, while developing a higher level of consistency and reliability.

For consultants and contractors who want to work on Heathrow but who have yet to encounter Project 13, embracing its principles will be a key requirement for Heathrow as it delivers its expansion programme.

“At Heathrow, we have set out the standards that we will need our partners to adhere to if they would like to help us deliver this major infrastructure project.

“All potential suppliers will need to demonstrate complimentary beliefs to be considered for this project and will need to play their part in keeping the promises that we have made to the airport’s local communities and pass strict environmental tests,” says Wilbraham.

“We’re also expecting the wider industry to learn from experiences

Special Report: Heathrow



KEY

- | | | |
|--|--|---|
| 1. New third runway | 5. Expanded cargo area | 10. Bath Road |
| 2. New passenger facilities | 6. New car parking with direct access to Terminal 5 (southern parkway) | 11. New Hatton Cross commercial development |
| 3. An expanded Terminal 5 and enhanced public transport hub merging into T5X | 7. M25 diverted beneath the new runway | 12. Existing North Runway |
| 4. Terminal 2, new passenger facilities and an enhanced public transport hub | 8. New pedestrian and cycling route | 13. Existing South Runway |
| | 9. New car parking with direct access to Terminal 2 (northern parkway) | 14. New Southern Road Tunnel entrance |

“We can build that new section offline from the motorway

from previous projects and consider how they will develop their businesses based on Project 13 principles.”

Market engagement has already started and contractors are being asked to express interest in the mega-project.

Procurement is expected to start next year before the main construction phase starts in 2022.

CONSTRUCTION PHASES

PHASE 1: 2022-26

This first phase will focus on building the third runway and will be the most construction-heavy period. Work on this phase will focus on earthworks; alterations to the M25 and junctions; local road and utility diversions; river realignment; construction of the North West Runway and airfield.

PHASE 2: 2026-33

With the runway up and running, the focus shifts to supporting infrastructure. This includes developing a new section of the A4, ongoing development of Terminal 5X, the

Northern Apron, Terminal 2A and supporting infrastructure. Further roads will be realigned including the new Southern Parkway and Southern Road Tunnel. There will also be significant work decommissioning the runway's construction support site.

PHASE 3: 2034-50

This phase will tie up terminal and parkway works, including further development of Terminal 5X, construction of terminals 2C and 2D satellite building and stands, Terminal 3 replacement and surface parking and road configuration.



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Michèle Dix

BY EMILY ASHWELL
AND MARK HANSFORD

Crossrail 2: maintaining momentum



Crossrail 2 managing director Michèle Dix can be forgiven for sounding a touch exasperated.

She is on stage at *New Civil Engineer's* Future of Rail conference and is explaining what is currently happening at Crossrail 2.

"Transport for the North speaks with passion about preparing to submit its first outline strategic business case to the government. We're about to submit our fifth," she states.

In her own words her team still has positivity, perseverance and patience, but yes, she admits, after putting together five business cases some of the passion has gone.

The £41bn project – £30bn at its 2014 baseline price – involves building a railway line linking south west and north east London, as well as destinations across Surrey and Hertfordshire. It has seemingly been whirling around a vortex of business cases, reviews and discussions for years. Dix took up the job in 2015, but this autumn's government spending review could give the clearest indication yet about its future. The Department for Transport will consider this latest business case and announce the next steps for the project.

"We're still governed by three P's: positivity, perseverance and patience," says Dix. "Whether we've



got passion or not – after five strategic outline business cases, there's less passion. But also, I think we're embarrassed about being passionate, because of this issue that the South has had enough, we should spend in the North."

Here Dix is referencing transport secretary Chris Grayling's

"I think we're embarrassed about being passionate, because of this issue that the South has had enough, we should spend in the North"

announcement in March 2018 that Crossrail 2 and the trans-Pennine rail route upgrade – a key element of the Northern Powerhouse Rail plans – are to advance in lockstep.

"We recognise the need for investment across the country. So we are not demonstrating that same passion you do observe in the North, but we're demonstrating the case very clearly," she says.

The first business case for Crossrail 2 was published in 2014. Since then Dix and her team have had to wait for the National Infrastructure Commission to back it, have had to make it more affordable, and have been told they have to work out how London can stump up half the cash for the project in advance. They have also had the plans scrutinised by an independent affordability review, and have had to review the whole project in the light of Crossrail 1 going over time and budget.

The Elizabeth line missed its December 2018 completion date and is now looking to a worst-case scenario opening date of March 2021.

"The Crossrail news obviously has had an impact. What we have been doing is to take into account the impact of Crossrail 1 on Crossrail 2 and to come up with a revised proposal for taking Crossrail 2 forward, hence the fifth strategic outline business case."

One of the main sources of

Crossrail 2 cash is being diverted to pay for Crossrail cost overruns



Crossrail 2's up-front funding was to be the mayor's second community infrastructure levy (MCIL2), which came on stream earlier this year. This money has now been diverted to pay for the completion of Crossrail 1.

"While that funding source (MCIL2) is not available, we have had to review our timetables," says Dix. "We've also had to take into account that we've got to ensure that the reputational image of the railway industry is such that people are confident in our ability to deliver. So, in our strategic outline business case we've put forward two timelines which reflect a realistic point at which you can start spending on construction, based on monies coming in."

Dix is purposefully vague about this timeline, simply saying the plan is still for the railway to be open in the 2030s. Previously the plan has been for it to open in the early 2030s.

Dix must now demonstrate that Crossrail 2 will avoid the huge setbacks which have hit its predecessor, and the team is busy learning lessons. She says the aim is not to do Crossrail 2 differently, but to simplify what was done on Crossrail 1 as well as repeating some work, but doing it better.

"There's lots of talk about innovation and new ways of doing things. If I make a lemon cake and the first one I make – it's not perfect, it doesn't work out as well, I then don't make some lemon meringue mille feuille

KEY FACTS

£41bn
Estimated
cost of
Crossrail 2

“A silver lining to the cloud is that there is more time in our programme for the pre-delivery planning

fancier thing. I'll make another lemon cake and I'll make it better the next time and then by the third one, I'll get better and I'll still make a really good lemon cake. It's how can we learn from things and do them better rather than learning from things and doing them differently," she says.

In this latest fifth case being tabled by the Independent Affordability Review will be put forward as an appendix.

The review, which was chaired by former Tideway managing director Mike Gerrard, considered elements such as the pros and cons of phasing the scheme, looking at wider funding sources to ensure all beneficiaries are paying and examining the role the private sector plays in terms of funding. For the phasing element in particular, Dix says she and her team considered the balance between each stage being delivered as an operational entity in itself, while minimising the cost of linking it to the next stage

when it is constructed. She says that by constructing the line in phases, the income from one completed section might help to pay for the next completed section.

All the delays have given Dix and the team more time, which she says will mean a better job in the long run.

"A silver lining to the cloud is that there is more time in our programme for the pre-delivery planning.

"Rather than thinking you have to do pre-delivery planning in parallel with gaining consent, so as soon as you've got consent you start digging, there's an opportunity to have some time to do that and to plan it in much more detail, so that you're packaging things up in a more optimistic, more optimum way.

"If you do it that way there's less likelihood of it being more costly."

But despite all the work, huge uncertainties hang over the project. How will it fund itself? How much money will the autumn Spending Review give the project – and depending on the size of any cash injection, how long can it keep going before a green light is given? But perhaps most importantly, in the light of Crossrail 1, is the question of whether the supply chain deliver it to time, quality and budget.

"I think the supply chain can do that," says Dix. "I think what we have to do is make sure that what we set out for the supply chain to deliver on time, budget and quality is well thought through".

Your View

LETTERS TO THE EDITOR
AND COMMENTS ONLINE

TRANSPORT

BAGGAGE DROP CONUNDRUM

Henrik Rothe thinks it's a good idea to make us drag our baggage into the city centre to drop it off then find our way from there to the airport (The Engineers Collective podcast, Episode 2). Two journeys where just one – to the airport with our bags – is much easier for us the passengers. The airport is the obvious location for the "centralised logistics centre" for baggage handling. If an airport wants more space they can build at the airport rather than in the city centre. But "entertainment venue" at the airport? No thank you. It will surely be overpriced and we really don't want it. We want our time at the airport to be as short as possible.

Stephen Palmer (AM),
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Editor's note: *Listen to Henrik's views on the Future role of airports by downloading New Civil Engineer's new podcast "The Engineers Collective". Available on Apple and Spotify*

PROFESSION

HOW TO GET GOOD QUALITY DESIGN INFORMATION

Although I share ICE vice president Ed McCann's concerns about the poor level of design information across many projects, I suspect the stated solution is misguided. The problem is often the result of people who are not culturally, or intellectually capable of the position being put "in charge".

I remember once discussing an issue of compliance and quality with a "manager" who, when I said "you do realise that because you're in charge of this thing, all actions of everyone working on the job, are as



though you personally did it" replied "well I'm not having that". I then had to explain to him that no one cared if he was "having it" or not. That was the reality.

If we restricted the appointment of engineers who control projects, or designs, or the appointment of survey commissions to only those who understand this concept I imagine far fewer drawings, schedules and specifications would be "approved" and rushed out.

What McCann has suggested sounds like a typically bureaucratic response to a cultural problem.

The result will be more time spent trying to tick the registered engineer box, and nothing else will change.

As a prime example I would cite movements such as Construction Line which have [in my experience] achieved nothing but add administration time to projects.

Chris Wozencroft (M),
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PROFESSION

DO WE NEED COMPETENT DESIGN ENGINEERS REGISTER?

ICE vice president Ed McCann is advocating that a list of engineers competent to sign off design drawings be drawn up to arrest the decline in quality of design information being provided to contractors.

This suggests that consultants are failing in their duty of care to clients. To stop such practice, if it exists, clients must sue the design companies. That will soon get rid of the problem.

Mario Donnetti (F),
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Editor's note: *Listen to Ed McCann's views on the skills issue in New Civil Engineer's new podcast "The Engineers Collective" too.*

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PROFESSION

STUART MUSTOW, A TRUE LOCAL GOVERNMENT PIONEER

I was greatly saddened to read the news of the death of Stuart Mustow (*New Civil Engineer* last month). I worked for him from 1974 to 1986 and found him a charismatic leader, good natured and articulate, quick witted and able to think on his feet.

I assisted him in the public inquiry into the proposed Wolverhampton Ring Road (Stage Six). He was given to power naps at lunch time, and sometimes I wondered where he would turn up for the afternoon session – but of course he did, and gave a sparkling performance with absolute mastery of all the facts.



Mustow: good natured, quick witted

The County Council was formed to take over the functions of seven former authorities and was consequently not popular among these bodies – however, it proved to be a pioneering and sometimes controversial council.

I worked on the Birmingham Airport re-development, designing aprons, taxiways, runway extensions and instrumental landing systems – the development featured (as far as I know) the first use of a maglev system to connect the airport with the nearby railway station. In practice, there were problems with unreliability and "hunting", so after a few years it was taken out of service.

Another innovative scheme I worked on was the guided bus project at Aston, just north of Birmingham city centre. This ran along the central median strip of a dual carriage way. Regrettably it did (Continued overleaf)

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MAIN POINT

WHAT CAUSED CROSSRAIL MESS?

Contrary to the views expressed in the letter from Derek Godfrey (*Your View last month*), the contractor's alternative of driving of the Crossrail TBM running tunnels first, on the western tunnels contract, did not increase tunnelling costs. In fact, it had the opposite effect of substantially reducing risk, produced a cost saving of \$80M and reduced the tunnel construction programme by seven months.

As it turned out, if this method had been adopted on the eastern running tunnels, then a lengthy delay to those TBM drives could have been avoided and might have brought about similar benefits.

This alternative was a major departure from the client's design of constructing the sprayed concrete lined (SCL) station tunnels first. It was in the winning western tunnels and stations tender by the Bam Ferrovial Kier (BFK) JV contractor.

The question of the price hikes is a bigger subject and in my view, lies at the heart of the selected procurement method for the design and construction contracts. Many Crossrail design and construction contracts were procured separately in relatively small packages.

For example, typically for a particular station site, the design, site clearance, piling and diaphragm walling, shaft sinking, station tunnelling, station fit-out and system services were often tendered and let as separate contracts. It can be argued that this method produces lower tender prices, since design, interface and co-ordination risk is taken by the



client. However, on such a complex project, this method of procurement will inevitably lead to much higher out-turn costs than the original tender price, especially with an incomplete and underdeveloped design at tender stage and contract award, such as was the case on Crossrail.

It is a fact that many design changes were made, with consequent compensation events, because of the severe lack of co-ordination of these interfaces and through the incomplete design, especially at the stations.

It is also worthy of note, and contrary Godfrey's letter, that the large cost hikes on the western running tunnel and station caverns contract did not result from procurement of the TBMs, advance rate, ground conditions, pre-cast tunnel segments or method of spoil removal.

Finally, I believe selection of the NEC3 form of contract was right, since this form, through effective collaboration of the parties, focuses on reducing risk, managing issues together and controlling the cost and programme.

The old ICE form was not appropriate for an incomplete client tender design, with too many interfaces, critical milestones and the need for regular monitoring and review of the construction programme. Whatever form of contract is used, the experience, competence and honest collaboration of the parties is what makes or breaks a successful outcome. Hopefully these lessons will be learnt for the next major infrastructure programmes.

Paul Glass (F), paul.glass@ymail.com

not survive for many years.

I had worked in local government since 1959 and have to say that project management was often somewhat lacking, however, under Mustow (and his very able deputy Keith Madelin) there was instituted a strict ongoing system to monitor costs and delivery dates.

Madelin of course went on to be the County Surveyor of Shropshire. Another of Mustow's protégés, Colin Clinton, went on to be a president of the ICE.

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TECHNOLOGY

WHEN WAS THE DIGITAL REVOLUTION?

I am intrigued by the use of the buzz phrase "digital revolution". For those of us whose career commenced before the advent of computers our professional life has been a continuous digital revolution with each leap forward being seen with trepidation as the end of engineers.

I have not noticed any change in the need for professionally qualified

engineers. Experience indicates that the current advances are a continuation of the evolution and engineers will readily adapt and take advantage of new challenges.

One of the concerns about the advancement of digital science is the dependence on sensors and software algorithms with the real risk that the results are taken at face value with no checks made on their validity. Recent events with poorly checked software resulting in crashed planes should serve as a warning.

Michael Helliwell (M ret'd), 12
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CONNECT TO BETTER

SEIZING THE SPACE

Seven women working in civil engineering have been recognised for their contribution to the industry. **Emily Ashwell** reports.

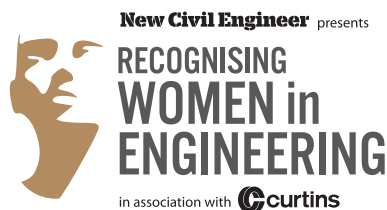
New Civil Engineer has honoured seven female engineers at the 2019 Recognising Women in Engineering awards.

The event, in association with engineering consultancy Curtins, aims to drive home the fact that gender diversity is good for business and recognise the value women bring to engineering.

There were more than 110 entries across seven categories, with judges including London Underground renewals and enhancements director Caroline Sheridan, Sir Robert McAlpine contracts manager Colin Campbell and Curtins head of communications Rhiannon Carss.

The women were honoured at a special dinner at The Ivy in London, ahead of International Women in Engineering day in June.

Here we set out the winners.



ABOVE AND BEYOND

Winner: Kate Cairns, founder, Cairns Consultancy

This category celebrates women who go above and beyond in a professional capacity – for example combining inspirational outreach work with excellent technical skills.

The judges said: “This award has been given in recognition of the dedication and drive Kate has brought to her campaign, called SeeMeSaveMe, to cut deaths and injuries involving HGVs. Her work has brought about an impactful change in behaviour and policy from lorry drivers on site to policy makers at a European level.”



TECHNICAL EXCELLENCE

Winner: Mercedes Ascaso Til, principal engineer, DLT Engineering

The technical excellence award celebrates women who are simply great at engineering, delivering excellence and innovation.

The judges said: “Mercedes shows leadership, passion and outstanding technical ability in her work on a bridge gantry design on the Canakkale Bridge in Turkey, which will be the longest suspension bridge in the world when finished. She took an engineering solution from concept development, through detailed design testing and to operation on site.”



CONTRIBUTION TO A PROJECT

Winner: Emily Shaw, programme manager, TSP Projects

This category recognises a particular contribution to a project in areas such as project management or transport planning.

The judges said: "Emily impressed judges with her work to gain a client's trust to revise timescales for the replacement of Leeds Station roof. Achieving buy-in and collaboration for a plan which minimised the standard length of revisions and approvals downtime, her work slashed timescales on the project. Now Network Rail is rolling out Emily's system nationwide."



LEADERSHIP

Winner: Catherine Wenger, director and West UK infrastructure group leader, Arup

The leadership award recognises women who have used their positions to inspire and engage the workforce and improve outcomes for customers and business.

The judges said: "The judges were impressed by Catherine's influence in promoting equality, diversity and inclusion. She is clearly an inspiration role model, demonstrating excellence and leadership in the workplace, including implementing a reverse mentoring programme and open-door surgeries."



Left to right: Emily Shaw, Anusha Sha, Catherine Wenger, Mercedes Ascaso Til, Leah Hidden and Kate Cairns

OUTREACH

Winner: Surekha Tangutoori, design engineer, Amey

The outreach award is for someone who goes the extra mile to inspire through promoting STEM in schools or mentoring young engineers.

The judges said: "Surekha's work is an example of simple, engaging outreach and is something all engineers can be inspired by. Through activities such as visits to primary schools and organising competitions for school children, the feedback, such as letters from pupils saying they now want to be civil engineers, shows the impact her work at a grass roots level is having."



CONTRIBUTION TO GENDER DIVERSITY

Winner: Anusha Shah, founder and chief executive, Plan for Earth

This category is open to inspirational men or women who have gone above and beyond to promote gender diversity.

The judges said: "Anusha has not just influenced, she has driven change through a range of activities to promote gender diversity from mentoring to public speaking. Her achievements include getting Institution of Civil Engineers policy, contracts and communication changed to include the values of fairness, inclusion and respect."



BUSINESS CULTURE

Winner: Leah Hidden, regional coordinator, BWB Consulting

This category recognises women who play a critical role in supporting project teams.

The judges said: "Achieving cultural change can be difficult, but Leah has stepped up from the role of office administrator to turn around a team which needed to boost morale and reduce staff turnover. Through organising a series of in-house and outreach activities, she has brought about what BWB managers say has been a cultural rebirth. Colleagues describe her as a 'phenomenal catalyst for change.'"



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Future of Rail

Current workloads in UK rail are uncertain. But what is certain is that the rail industry is entering a period of exceptional change. Opportunities are there to be grasped whether through hyperloop technology or use of digital twins

CHALLENGES FACING THE UK MARKET / PAGE 28

OPPORTUNITIES FOR INVESTMENT / PAGE 34

THE GROWING NOISE AROUND HYPERLOOP / PAGE 38

THE ROLE OF THE DIGITAL TWIN / P42

ACCELERATING PROJECT DELIVERY / P46

UNCERTAIN JOURNEY?

Current concerns about workload mask a broader, positive future for the rail industry. Or do they?
Katherine Smale reports.

Future of Rail

Working in rail is a little like Marmite, you either love it or hate it. But as the UK market goes through challenging times, even those that love it will find that love tested.

The seemingly never-ending list of uncertainties include the impact of Network Rail's devolution, the outcomes of ongoing reviews and ongoing funding uncertainties affecting major projects such as High Speed 2 (HS2), Northern Powerhouse Rail and Crossrail 2.

But the biggest uncertainty is the lack of an enhancements pipeline in Network Rail's now underway in Control Period 6 (CP6) investment programme.

There is around £2bn of new work in the rail infrastructure owner and operator's £10bn enhancements pot for the next five years – the other £8bn is for work left over from Control Period 5 (CP5) which ran from 2014 and 2019.

But for reasons best known to itself, the Department for Transport (DfT) has yet to publish details of what the £2bn will be spent on,

KEY FACTS

£10bn
Network Rail
spending on
enhancements
over the next
five years

£2bn
Actual
spending on
new projects
over the next
five years

despite growing calls from the industry for it to do so.

Speaking at the *New Civil Engineer* Future of Rail conference Network Rail head of client portfolio Yaelle Ridley said she would like to share the list of projects, but was prevented from doing so by transport secretary Chris Grayling.

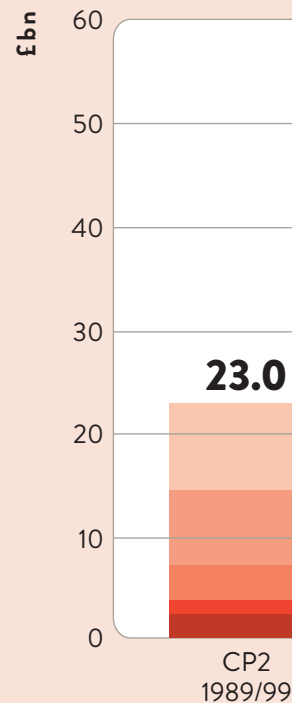
"The question I always get asked is: 'great, so where is the list?'," she said. "Let's tackle that one head on, I can't share it with you I'm afraid."

"We've been specifically told we can't share the list, we struggle to share it even within our own organisation which makes it very difficult for future planning."

After several major contracts in CP5 went over budget, funding for large scale infrastructure projects was split out from the regulated control period cycle to shake up the way enhancement projects are financed.

The £1bn upgrade of London Bridge station, which was part of the CP5 workbank and completed last year, is one example of an

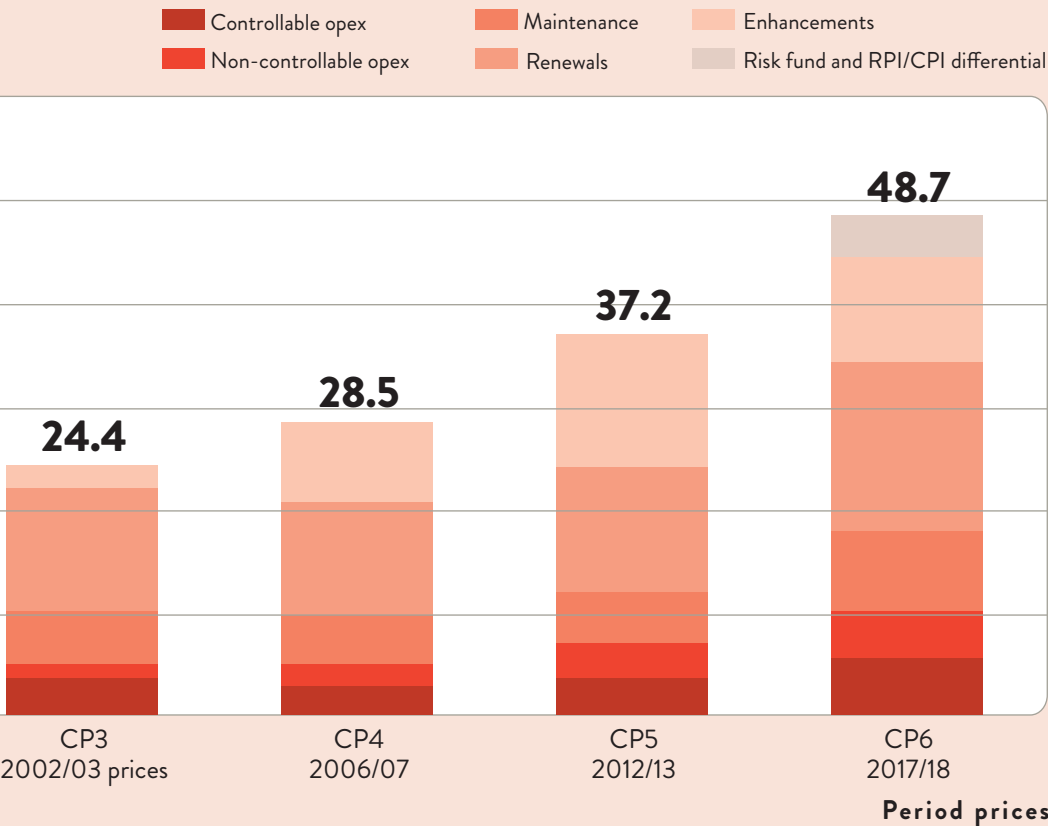
“The question I always get asked is: ‘great, so where is the list?’”



CP6 2017/18 PRICES (£bn)

Controllable Opex	6.0
Non-controllable Opex	4.3
Maintenance	7.7
Renewals	16.6
Enhancements	10.0
Risk fund and RPI/CPI differential	4.0
TOTAL	48.7

NETWORK RAIL FUNDING SETTLEMENTS CP2 - CP6



“Rail is being bought by this government like no other government in British history

enhancement project.

Ridley acknowledged that uncertainty about the pipeline has led to tension in the supply chain with some tier 1 contractors saying they would to re-evaluate their relationship with Network Rail. They fear a two year lag in enhancements work and a tail off in work.

“I know for the supply chain that’s [a] difficult a place to be and what that means for supply chain engagement on big and small projects and everyone appreciates that,” she told the conference.

But rail minister Andrew Jones told the conference that he disputed that withholding the pipeline was a cause for concern.

“Hang on there, we’ve been talking about record levels of budget. If you look across where most industries are, do most industries have a guaranteed market place of several billions of pounds a year?” he said.

“We will indeed publish the enhancements plan, we haven’t published it yet, we will think about how we will do that. But really it should not be thought of as some kind of concern that undermines the bigger position.”

He went on to say that the supply chain should “take a pace back” and think about the competitive marketplace that we are in where other sectors would think, “this is great”. Rail is being bought by this government like no other government in British history. Like no other government across Europe, so start getting with the programme of being positive,” he said.

In response to the clampdown on project visibility, the Railway Industry Association (RIA) renewed its calls for the government to publish the pipeline. In March the lobbying body wrote an open letter to the DfT stressing the importance of having visibility of upcoming infrastructure projects to allow businesses to “plan and to establish appropriate resource levels”.

It is unquestionably a situation that is making predicting what work there will be and how to win it tricky to say

HS2 CONSTRUCTION TIMELINE TO 2021

MAY 2019

Start construction of Euston Station

AUG 2019

Chilterns tunnel commences

SEP 2019

Start construction of Old Oak Common Station

DEC 2019

Phase 2a hybrid Bill Royal Assent target date

Q1 2020/21

Phase 2a Enabling Works commence

Q2 2020/21

Rolling stock Contract award

Q3 2020/21

Start construction of Birmingham Stations

Q4 2020/21

Rolling stock Detailed design commences

Begin implementing Asset Information Management System

2019/20

2020/21

“For backers of HS2, how much it will cost is still the elephant in the room

the least.

But there is hope. From the Hansford review in 2017 came the Network Rail “open for business” initiative aimed at making the company easier to work with. Suppliers are now able to challenge standards more in the drive for efficiency.

It also led to the government putting out a call for ideas for private funding of railway projects – known as market let proposals – which has the potential to inject well needed funding into the cash strapped industry.

Although this appears to have been somewhat hampered by the cancellation of the privately financed PFI and PF2 infrastructure procurement models, new models are being considered in the government’s Infrastructure Finance Review which is expected to be published this year.

This gives hope for the future of the 10 schemes that made the cut in December last year but which have seemingly now disappeared into the ether.

The “root and branch” review of the rail sector currently being carried out by independent chair Keith Williams will also hopefully result in a step change in the way the industry is run. The move to make it more financially sustainable, give better value for money for passengers, reduced disruption and increased reliability can only be a welcome result.

Indeed, preliminary outcomes of the review are already being taken forward. With the arrival of the new Network Rail chief executive Andrew Haines last autumn, the organisation has made a major move to put passenger needs first.

“We are seen as bureaucratic, slow, difficult and arrogant, and have too many people too many steps away from the real-time running of the railway,” he said at the time of his appointment.

And although Haines has canned



“We are seen as bureaucratic, slow, difficult and arrogant

the formal digital rail strategy, there will still be opportunities to roll out new digital technology through signalling upgrade programmes. This is an area which will no doubt revolutionise the railway, allowing trains to run closer together to maximise capacity and giving passengers more information about delays.

Tenders for the first package of work to carry out the digital upgrades are due to be published later this year.

Devolution, another Network Rail initiative, is also an unknown entity but one that is broadly being considered to be a positive step forward.

In a shake-up to the way the organisation is run, Haines has made the move to split up the central running of Network Rail into 13 geographical regions to make them “more responsive” to train operators’ franchises and “enable track and train operators to work closer together”.

HS2 in all of its phases, is of course the other current and future major disrupter in the rail industry.

The new line will give much needed additional capacity throughout the country. Councils and newly formed development corporations are already making bold plans for the areas around proposed stations such as Old Oak Common to capitalise on the economic growth potential (*see box*). It is also already pushing boundaries with new technologies, speeds, and setting new environmental standards.

But for backers of the scheme, how much it will cost is still the elephant in the room and it will be very much down to engineers, contractors and their supply chains to come up with the solutions to enable it to go forward.

Despite the challenges, there are opportunities, which if they come to fruition will create massive opportunities to revolutionise the railway and a pipeline which will stretch out for decades to come. **N**

OLD OAK COMMON HS2 STATION

“The thing is that this, on a scale of HS2, has never been done before”

Old Oak Common station in west London will be the penultimate station before the High Speed 2 (HS2) trains from the North terminate at Euston station around 20km away in central London.

Around 48,000 people will move through the station in the three-hour morning and afternoon peaks rising to 64,000 people, 30 years after HS2 opens.

The station will cost a whopping £1.3bn to build, but this hefty price tag reflects its colossal size.

At 900m long, 60m wide and 20m deep, it will be the biggest sub-surface railway station in the UK.

From the east, trains will enter the station from the Euston tunnels 12m below ground level and leave via the Northolt tunnels on the way to Birmingham and further north.

The station is being designed by WSP and architect Wilkinson Eyre. A contract to build the station was awarded to a Balfour Beatty/Vinci/Systra JV in February, but due to a legal challenge by rival bidder Bechtel, work has been postponed pending the outcome.

The site itself is incredibly complex.

“The site is incredibly constrained,” says Wilkinson Eyre director Bosco Lam. “We have the existing mainline services to the south which create an impermeable edge. The HS2 alignment was fixed at 12m underground which gives us a hard boundary to the north, plus



Old Oak Common station will be 900m long and 60m wide

the recently finished Elizabeth line depot. The only public access is off Old Oak Common Lane, which is a constrained road in itself.”

The station will integrate the HS2 line with below ground platforms on the Great Western line with ground level platforms.

A bridge will link the two but Lam says the station should be viewed as one complete station, not two separate entities.

We want an architecture that reinforces that it’s a seamless journey, it’s smooth and you can do everything and have the flexibility within that.”

This vision of one station also neatly allows the designer to keep the space flexible, giving large column-free spaces to ensure that future technologies are unconstrained by the arrangement of the building.

But the idea of a single unified station has brought its challenges with the design for

fire, operational independence and resilience between different operators all having to be resolved.

To future-proof the design, Lam says safeguarding is needed to enable the surrounding development – being carried out by the Old Oak and Park Royal Development Corporation (OPDC) – to make future connections to the site.

As the surrounding area will still be being developed, on day one of the station opening, only 17% of passengers are forecast to leave or enter the station, with the majority interchanging rail to rail.

Lam says this puts a bigger focus on the ease and clarity which would normally be within an interchange.

“The thing is that this, on a scale of HS2, has never been done before and that brings a lot of testing and engineering challenges to that process.”

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ADDING VALUE

Europe wants the UK to teach it about driving social value and placemaking into railway stations via third-party investment. But getting investors involved is a challenge, reports **Connor Ibbetson**.



Network Rail and Kier are developing 115 apartments around Twickenham station in west London

If you have recently taken the Eurostar from Brussels Midi or Paris Gare du Nord to London St Pancras, you will need no further evidence of why Europe is looking to the UK when it comes to driving private investment in rail – starting with stations.

Brussels Midi is dark and depressing, the Gare du Nord is slightly cheerier, but arrive in London and passengers are met with a concourse filled with tempting cafés, upmarket shopping and a buzzing atmosphere. This has in part attracted £2.2bn of private investment including new offices, jobs and homes around Kings Cross. Now Euston is set to follow suit with the introduction of High Speed 2 (HS2).

“Recently I’ve been working in France with Société du Grand Paris, the metro project for Greater Paris,” says Grimshaw Architects partner Declan McCafferty. “What is interesting to me is from the European continental perspective, they think they have a lot to learn from the

KEY FACTS

£500M
Value of
oversite
enabling work
at Euston
station in
London

way railways have been developed over the last 10 years in the United Kingdom.”

While the Europeans may be well versed in planning strategic rail, they are looking to the UK to see how third-party investment and specifically placemaking around the railways can drive growth in the sector.

“In particular what [the Europeans] see are placemaking benefits,” McCafferty says. “They are very good at getting development over railways, a lot of which are cut outs which makes things easier. But what they don’t get is the type of placemaking around their stations we are starting to get, particularly in London, and

how that placemaking drives value. They are very good at strategic planning for rail, but less good at creating places around railways where people want to live and work.”

Euston is a prime example of how the UK is driving this placemaking and social value return on rail assets, says Infrastructure Projects Authority director of infrastructure delivery Stephen Dance.

Developer Lendlease is developing the masterplan for the new Euston station and its surrounding area.

The station, a key part of HS2, is a unique example of where early investment of public money is set to drive increased social value and growth through third-party funding later down the line.

“We persuaded the Treasury to allocate close to £500M of public capital for the enabling works for oversite development at Euston. This was an opportunity to highlight the fact that private capital paying for the enabling works would have meant investors would have to invest far

“What the Europeans are seeing is placemaking benefits

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“Money is coming from the government to fund capacity, but our station environments can’t cope

ahead,” adds Dance. This carries the risk of investors being deterred from investing too early in a project, fearing that they will have to wait too long for a return.

Although barriers bringing third party investment into the industry remain, there are some examples of success.

Solum is a partnership between Network Rail and Kier Property. It was set up to bring private investment into rail network by reinvesting profits from the sale of new homes back into the railway. It is currently developing 115 apartments above and around Twickenham station in south west London.

However, working within rail can be daunting for some private investors.

“Rail is a safety critical environment,” Biggs says. “And land developers can find us difficult to work with unless they are used to that environment.”

But safety is far from the only challenge. Last year Network Rail undertook a shake-up of its standards as part of its “Open for Business” programme to try and attract more investment.

The track operator streamlined more than 400 standards to reduce cost and complexity and encourage innovation while maintaining safety standards.

“Network Rail Open for business is looking to make it easier for business to work with the railway, and we are proactively looking for and helping people to work with us,” Biggs adds.

“Lots of money is coming from the government to fund capacity but our station environments can’t cope. There are huge opportunities to regenerate these stations going forwards and property is one area



where we can do this, and they can help maximise the value of these sites.”

The Open for Business programme is Network Rail’s response to the 2017 Hansford Review, which examined the potential in the UK rail market for third party investment in and infrastructure delivery on the national rail network.

The report led to the Department for Transport (DfT) launching its call for market led proposals (MLPs) in March last year, in a bid to encourage the construction of more privately financed rail schemes in the UK.

Despite a year having passed, none of the 10 schemes being considered by the government has received feedback.

The DfT is due to respond in the autumn but the long wait has led to some schemes losing investors seeking answers to things including queries about intellectual property rights.

Another challenge facing the

Euston’s High Speed 2 station is seen as an opportunity to drive investment in the surrounding area

network is that of attracting significant investment outside central London. The redevelopment of Old Oak Common, where HS2, traditional rail and Crossrail all intersect, is a prime example.

Biggs argues that developers must be shown the potential for projects like the Old Oak Common development to transform areas into new “economic engines”.

“Ability to look at wider value capture is vital,” says McCafferty. But even with the more attractive central London schemes, this can be hard, especially with cultural differences between the property development and rail sectors.

“If we had a better way of capturing that wider value, we could make more of these schemes, even at Euston in central London. To make these schemes work is tricky. The longer timescales are easy for the rail industry to get our heads round, but it is difficult for developers to understand, it’s a cultural thing.” **N**

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CATALYST FOR CHANGE

As hyperloop technology gathers pace, the UK government is being urged to invest or risk being left behind. Report by **Rob Horgan**.

Future of Rail

When invited along to *New Civil Engineer's* Future of Rail conference in June, several contractors, engineers and trade journalists quipped back that “there is no future in rail”. And perhaps, they are right.

Rail as we know it is approaching the end of its shelf life. But while it may be true that there is no long-term future for lollypop signals, train guards, pacer trains, or even steel railway train tracks, that does not mean there is “no future in rail”.

In fact, the industry has never sat on the parapet of such a vast array of opportunity since the industrial revolution. Be it hydrogen-powered trains, digitised railways or – and this is where pulses start racing – hyperloop, the future of rail is as wide-ranging as it is utterly terrifying to the old guard.

If its potential can be fulfilled, hyperloop will completely disrupt the way the world thinks about infrastructure, the way companies do business and most importantly the

KEY FACTS

1,100km/h
Target speed of hyperloop train being developed for Dubai

way people move around.

There are already calls for the UK to start investing less in traditional rail and more in hyperloop development. In November last year, the Transport Research Laboratory (TRL) called for the establishment of a UK hyperloop centre of excellence, warning that the government’s “wait-and-see approach” to hyperloop means the UK could miss out on future transport opportunities.

At *New Civil Engineer's* Future of Roads conference last month, think tank 311 Institute chief executive Matthew Griffin went one step further and claimed that the UK should “rethink” its £56bn investment in High Speed 2 (HS2) and plough the money into hyperloop instead. Hyperloop services run in vacuum tubes which allow them to travel in a frictionless

“The tunnelling industry is integral to the development of hyperloop

environment at very high speeds.

“The number of transportation options we have available to us, even in the next 10 year, is going to accelerate phenomenally. This comes down to the approach of the regulators, cost of the platform, and culture,” Griffin claims.

The ICE is also backing the development of hyperloop technology in the UK. Earlier this year the Institution put up funding for the British Tunnelling Society to investigate ways to bring down the cost of tunnelling with a view of one day running hyperloop tubes under UK soil.

As British Tunnelling Society past chairman and Parliamentary liaison lead Bill Grose explains, the only viable way of running a hyperloop network in the UK is underground.

As hyperloop tunnels must be as straight as possible, Grose explains that “the most logical way in built up cities or countries is to go underground”.

“Hyperloop is not just a massive opportunity for the tunnelling industry, but the tunnelling industry is integral to the development of hyperloop,” Grose says.

“I think in the far future hyperloop is going to be a massive opportunity for the tunnelling sector. If the





technology is proved to work above ground then I think demand to put hyperloop beneath ground will quickly come around.”

He adds: “It is just like rail. Nowadays we are used to underground systems, however when rail first started it was all above ground. It is the same with roads.

“If hyperloop is a success, then it is inevitable that cities will want routes connecting to one another underground rather than above ground.”

The sticking point – as Grose explains – is cost.

When serial entrepreneur Elon Musk unveiled the blueprint for hyperloop, he claimed it would be “economically unviable” to put the tubes underground unless tunnelling costs were slashed tenfold.

To put that into context, the tunnelling for Crossrail cost more than £2.5bn, according to public spending watchdog the National Audit Office.

For hyperloop to become a reality, the cost of tunnelling the same 42km stretch would have to come down to no more than £250M. “In terms of reducing costs we are looking at the UK to lead, however nobody expects the UK to have one of the world’s first hyperloop networks,” Grose adds.

Virgin Hyperloop’s test track in the Nevada desert

“What we are hoping for, as a spin-off of this investigation, is to bring tunnelling costs down so that we can start to explore new technologies such as maglev and then potentially hyperloop somewhere down the line.”

Grose explains the vacuum tubes in which the hyperloop capsules will travel would probably have to be installed inside tunnel ducts for hyperloop pods to reach speeds of up to 1,200 km/h.

The BTS is currently examining how much space would be needed between the outside of the tubes and the tunnel walls for maintenance to be carried out.

The investigation was started in spring this year, and the BTS will have its first findings ready to share with industry experts in September with the aim of publishing a full feasibility report before Christmas.

Outside of the UK, hyperloop systems above ground are somewhat closer to reality.

Two companies are leading the charge, with US-based Hyperloop Transportation Technologies (HyperloopTT) led by the enigmatic Bibop Gresta; and Virgin Hyperloop One, backed by Sir Richard Branson.

Within the realm of hyperloop development, these two companies are miles ahead of any other firms exploring the technology’s potential.

“If hyperloop is a success, then it is inevitable that cities will want routes connecting to one another underground

HyperloopTT is working to create Europe’s first-ever Hyperloop track in France and is also developing commercial routes in Abu Dhabi and the Czech Republic.

Meanwhile Virgin Hyperloop One is ploughing on with its own plans. As well as working on a commercial route in India, the Hyperloop One team is drawing up plans for three commercial routes in the US – in Ohio, Missouri and Texas – after successfully trialling its technology at its 500m long test track in Las Vegas (*New Civil Engineer* June 2018).

Speaking to *New Civil Engineer*, Hyperloop One materials engineering manager Kristen Hammer said the “biggest stopper” to rolling out the technology was regulation.

“At the moment, there is no regulation around hyperloop,” Hammer says. “We are working closely with different authorities and with the White House to get the regulations in place.

“The benefit from an engineering point of view is that we have more time to make sure that when the regulations are in place we are ready to go and ready to deliver the systems.”

As well as dramatically slashing journey times between cities, Hammer claims that hyperloop will revolutionise the way people live, allowing people to commute “hundreds of kilometres” to work.

She also claims that hyperloop will play a massive part in reducing carbon emissions, as it will be solely powered by electricity.

Virgin Hyperloop One estimates worldwide flights alone produced 859M.t of CO₂ in 2017. The company estimates it would be possible to reduce fossil fuel emissions from flying by 58% if every passenger flight between 500km and 1,500km was replaced with a hyperloop journey.

“Hyperloop has the power to improve the way we live, make the world a cleaner, a more connected place and improve journey times,” Kristen concludes.

What’s not to like? **N**

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GREEN LINES

Cutting carbon emissions in rail was the challenge at New Civil Engineer's High Speed Hack. **Connor Ibbetson** reports.



The winning Aecom team

A team of graduates from Aecom won a transport innovation award following a full day competition at *New Civil Engineer's* Future of Rail conference last month.

Teams of engineers, planners and consultants were set the task of solving one of three transport problems centred around passenger experience; sustainability; or using data to improve asset management.

The winning team, took on the sustainability challenge and proposed a publicly accessible Cloud-based application tracking carbon emissions to promote a more efficient railway.

Aecom transport planner Samantha Taylor, sustainability consultant Eleanor King, and civil engineers Anthony Carr and Cameron Dalziel proposed collecting emission data from trains to promote more sustainable rail travel.

"Our solution would be data collection of carbon emissions across all types of routes, all types of train, and uploading them to one unified central database," Carr said. "Sixty three per cent of carbon emissions in rail are from rolling stock, so we are

KEY FACTS

63%
**Proportion
of rail carbon
emissions
coming from
rolling stock**

aiming for a big-ticket item to make an impact. We need something that will affect both current and future railway."

"A key issue within the industry we have identified is that train efficiency data between routes and types of rolling stock is not widely shared between train operating companies," Dalziel adds. "This integrated solution would allow it all to be assessed on the same basis."

The team said the publicly accessible database would also allow customers to determine their most sustainable route of travel on the railway, in a similar way to the way the fastest and cheapest routes are calculated. This would encourage competition between train operating

companies to provide the lowest-carbon service, the team said.

There would also be a business case for applying a similar system to rail freight.

The biggest barrier the team identified would be retrofitting passenger load sensors and emissions monitors onto older rolling stock.

It was suggested that this could be funded with an increase in track access charges for more polluting trains.

Speaking on behalf of the judging panel, Infrastructure and Projects Authority programme director for modern methods of construction William Varah said the Aecom team's suggestion would have a great benefit to the public.

"The entry from Aecom picked something very specific and achievable. We already collect carbon data and a new Cloud platform is very achievable with low barriers for what would be a great benefit to the public."

Judges were Amey commercial account director Anna Delvecchio; Network Rail senior civils engineer Jenny Cooke; and SenSat global business development manager Roger Skedd.

“Train efficiency data between routes and types of rolling stock is not widely shared

Debate: Future of Rail

DEFINING THE DIGITAL TWIN

DEBATE BACKGROUND

£10bn

**Revenue from
digital twins by
2023**
(Jupiter Research)

2019

**Year Newcastle
became the first city
in the world to have
a digital twin**

20 years

**Length of time
McLaren has
been using
digital twins in
motor racing**

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Digital Twins could be the most disruptive tool for engineers to emerge since BIM, but before the sector can utilise their full potential, it needs to agree – what is a digital twin in the context of civil engineering and how best to use it. At New Civil Engineer's Future of Rail conference, industry experts came together to discuss the potential for digital twins in rail.

Connor Ibbetson reports.

Data is infrastructure" according to the National Infrastructure Commission's 2017 report, *Data for the Public Good*.

The strong link between the digital and real world can improve how we build our infrastructure, manage it to maximise its life, and eventually decommission it. Nowhere else is this link better demonstrated than in the digital twin.

The Centre for Digital Built Britain is a partnership between the Department of Business, Energy & Industrial Strategy and the University of Cambridge to deliver a smart digital economy for infrastructure and construction. It says a digital twin is a "realistic digital representation of assets, processes or systems in the built or natural environment". A true digital twin is separated out from a traditional model by its connection to the real-world counterpart.

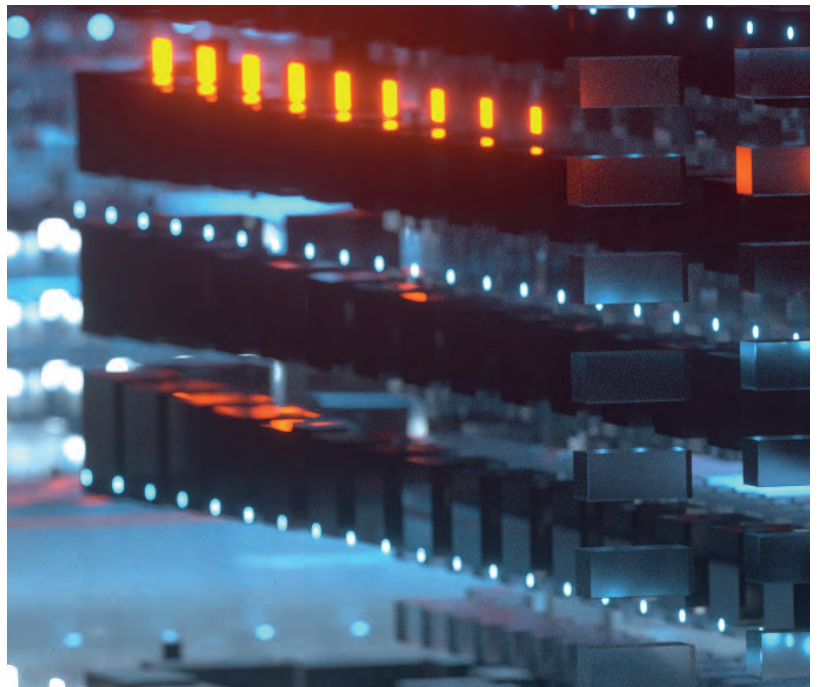
However, to most people, the phrase "digital twin" suggests a BIM-style 3D asset render. But digital twins have the potential to go far beyond such a simple static model.

The concept has been around for a while. Space research body Nasa and motorsport giants McLaren have been respectively using digital twins of spacecraft and engine components for decades to great effect.

While the infrastructure sector can learn from the likes of Nasa, its digital twins are on a whole other scale with levels of complexity not encountered before.

Those at the round table agreed that the civil engineering sector needs a unified approach to adopt the digital twin concept.

That starts with working out what digital twins mean to us and just how



they will be used.

"I've probably been given 50 different definitions for what a digital twin is," Network Rail programme manager Robert Forde laments.

"For me, we have to define what it means to us as an industry, work out what the gap is between where we are and where we want to be 20 years down the line."

Forde adds that digital twins should not just be considered for new

projects, but that the sector should work out how data and information about existing assets in the ground can be leveraged. This will give a greater understanding what the real life of an asset is and develop proper degradation modelling.

"We are light years away from the aerospace industry, and we need a plan, we need some hard graft before digital twins start giving us truly useful insight," he says.

Bentley Systems chief product officer Bhupinder Singh adds that it is vital that people remain open with digital twin technology, or the industry will risk losing the context that gives them meaning. "The purpose of the digital twin is making insights, but this is only possible with an accurate context, if you don't

“I’ve probably been given 50 different definitions for what a digital twin is

“Having come from the aerospace industry, a digital twin means something very different to me than it means for construction

have an open data platform, this is incredibly hard,” says Singh.

Laing O’Rourke director of digital technologies Graham Herries agrees that for the civils sector to truly take advantage like other sectors have successfully done, data must have context.

“Having come from the aerospace industry, a digital twin means something very different to me than it means for construction at the moment,” he says.

“A digital model and some data do not make a digital twin without understanding of the context, simulation, state, and those other aspects that are vital to leveraging the true power of the digital twin.

“Without that, data is just data. It’s not about that it’s about the information and knowledge generated with that data.”

But the sector is already starting to change. Atkins digital engineering lead Jerome Jemmotte, who has been working on the East West Rail Alliance, says his project is trying to turn a digital twin into an outreach tool as well as an engineering and asset management tool.

“The East West Rail Alliance is an alliance of Network Rail, and private partners Atkins, Laing O’Rourke and VolkerRail, who all have an equal stake in the project, so we want to make sure that everyone has access to that data, but didn’t start out with a vision of a digital twin,” Jemmotte said.

“We have the same issues that High Speed 2 and other projects had in that we had a lot of data and currently there is no way of amalgamating that into one easily accessible system. We started out with just CAD data,

AT THE ROUND TABLE

This report is informed by a round table debate held at New Civil Engineer’s Future of Rail conference in May. The debate was held in association with Bentley Systems. Around the table were:

Mike Coldrick strategic channel advisor, **Bentley Systems**

Robert Forde programme manager, **Network Rail**

Mark Hansford editor, **New Civil Engineer**

Dr Graham Herries director of digital technologies,

Laing O’Rourke

Philip Hoare president, **Atkins**

Jerome Jemmotte digital engineering lead, **Atkins**

Adrian Malone head of digital project delivery and

BIM for transport & infrastructure business, **WSP**
Chris Mundell innovation manager, **Atkins**

Richard Shennan digital business development director, **Mott MacDonald**

Bhupinder Singh chief product officer, **Bentley Systems**

Mark Thomas product line manager, **Siemens**

William Varah programme director, modern methods of construction, **Infrastructure and Projects Authority**

Alexandra Wynne deputy editor, **New Civil Engineer**

Sonia Zahiroddiny interim director (BIM) and BIM strategy manager, **HS2 Ltd**

Richard Jones technical & innovation manager, **Rail Industry Association**

FURTHER INFORMATION

Data for the public good, National Infrastructure Commission

www.nic.org.uk/wp-content/uploads/Data-for-the-Public-Good-NIC-Report.pdf

The Gemini Principles, CDBB

www.cdbb.cam.ac.uk/

system/files/documents/TheGeminiPrinciples.pdf

● **New Civil Engineer is recording a special episode of its podcast, the Engineers Collective on Digital Twins. It will be broadcast in August on NCE’s website newcivilengineer.com**

but there is also GIS map data, non-graphical information, asset registers – how do we bring this together into a single platform for all the partners to access?”

The East West Rail Alliance also wants to give people outside engineering visibility of design information as it progresses through the design cycle early on, with the aim of allowing end users of an asset to influence a design at an early stage before it is issued to the client.

“Bentley Systems and its iTwin technology has opened the door for us to start this,” Jemmotte says.

The iTwin technology is an open source cloud platform that combines several services to collate

information and allow organisations to create, visualise and analyse digital twins of infrastructure projects and assets.

Because the platform is open source, the East West Rail Alliance is working on incorporating it with augmented reality software used in high-end video games to feed live data into real-time simulations of assets. It is hoped this will produce a powerful tool that can be used to better explain a project to an end user, as well as other engineers.

Mott MacDonald digital business development director Richard Shennan says this idea of using digital twins as outreach tools is also on his agenda. “Something Mott MacDonald has been looking at doing with digital twins is connecting to social needs,” Shennan explains.

“If you have a digital twin which is combined with predictive models of social outcomes of various interventions in the system, then you start to get to a higher level of decision making.”

There is only a limited amount of money available, he says, and using digital twins in this way can help drive maximum value from infrastructure investment. This type of infrastructure simulation and resulting societal impacts is exactly what Northumbria Water and Newcastle University have done in

creating the first city-wide digital twin for Newcastle (*see case-study*).

But Atkins president Philip Hoare sees the digital twin concept as a predictive tool, and one that could turn the fortunes of the industry around.

"Look at construction industry performance in the UK, the current model is broken, and I think the digital twins are part of the solution to breaking the cycle," Hoare says.

"One of things that kills project is changes that happen during the project, and the cost increases and delays that result are killing our industry. Digital twins could help us break out of this cycle and uncover all or most of the problems with a project before construction even starts."

Hoare says that for this to work, clients must understand the value added to the entire life of an asset, the added security during its construction and how that justifies a bigger upfront cost.

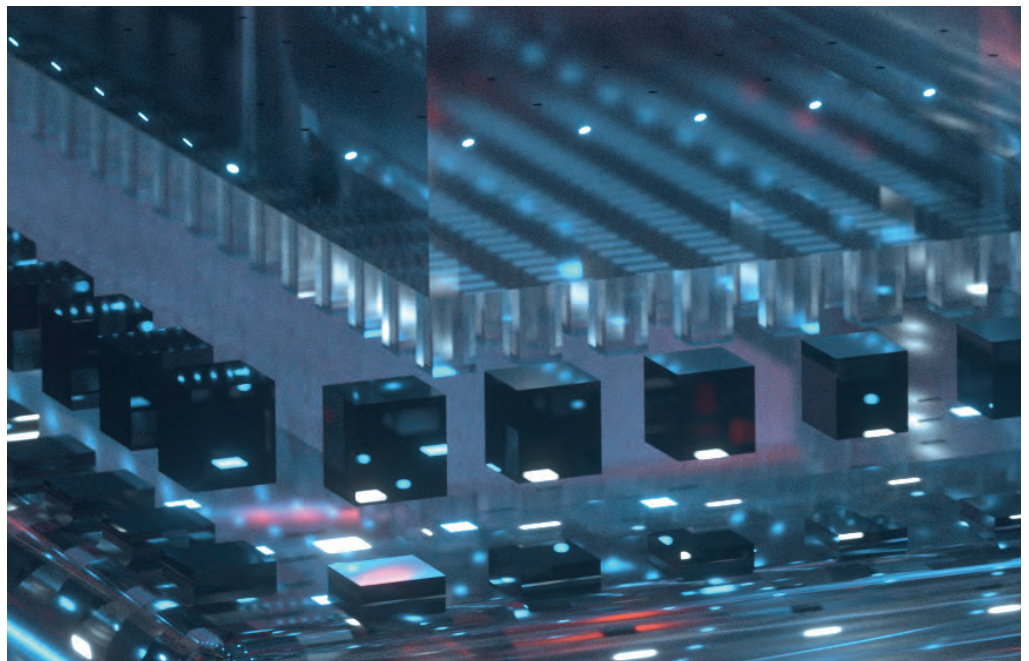
Bentley Systems strategic channel advisor Mike Coldrick argues that herein lies the issue. Digital twins must become part of contracts from the get-go and may even need a jump start from the government to make this the norm.

"We can talk the talk about how fantastic this technology is, but if it is not in your contract from the start you just aren't going to do it," Coldrick says.

"BIM level 2 needed the government to intervene and make it a requirement before anybody really bothered to get on board with it. Are we going to need the same requirement from the government to kick start digital twins?"

"HS2 Ltd has had a fantastic idea, two contracts, one for a digital twin and one for the asset, if the client likes the digital twin they accept the second contract."

“HS2 Ltd has had a fantastic idea, two contracts, one for a digital twin and one for the asset



HS2 Ltd interim director (BIM) and BIM strategy manager Sonia Zahiroddiny says that for HS2, digital twins are enablers, but not the whole answer.

"A digital twin is not just the visual representation of the design, there is another level of complexity which takes us into the world of the Internet of Things and the connected environment. I see the technology as an enabler but not the answer," says Zahiroddiny.

"We [HS2] are starting to look

at the big picture and as we move through construction, we have been installing sensors and smart devices to help create our digital twins which will help to enable our predictive maintenance programmes.

"The more I engage with my systems engineers," Zahiroddiny adds, "the more I realise the question has now become how we bring together BIM, the internet of things and digital twins into one package and embed it into the engineering process." **N**

NEWCASTLE'S DIGITAL TWIN

The city of Newcastle has already become the first city in the world to use digital twin technology to recreate the entire city digitally to help planners stress test the city's infrastructure in response to climate change and population growth.

The digital twin is a virtual model of the real-world city, combining geospatial and performance data overlaid with operational data to produce a model that can be tested under various scenarios.

The system is capable of visualising changes across the city in real time, allowing researchers to examine the impact of environmental and

human changes.

For example, the project's backers say the digital twin could be used to visualise the routes people would use to escape in the event of a flood.

Work to create the digital twin comes from a partnership between Northumbria Water and Newcastle University, which started at the Northumbria Water Innovation Festival.

The data for the project is mostly being supplied by Newcastle University's Urban Observatory, which has sensors deployed all over the city, collecting 50 types of data for things as diverse as air quality, human traffic and water levels along the River Tyne.

Debate: Future of Rail



DELIVERY CHANGES

DEBATE BACKGROUND

50%

Proportion
of freelance
workers by
2030

1%

Percentage of people
using trains in the
North

80%

TfL target for
people walking,
cycling or using
public transport
by 2041

In association with

AECOM

Rail schemes will be competing for funds with projects which are higher on the government's list of priorities and which deliver more obvious social value. So how should the industry respond in promoting options?

Solutions could be to improve productivity, propose alternatives to heavy rail or to find alternative funding.

Jackie Whitelaw reports.

Unless the rail sector improves productivity and value for money, is there not a danger the Treasury will spend billions on 5G rather than, say, large capital projects? That was a question posed by Aecom director of strategic advisory Shamit Gaiger for a discussion on funding and delivering future rail schemes. The discussion was held at a round table debate held at *New Civil Engineer's* Future of Rail conference in June.

Gaiger's question has the issue summed up in a nutshell. Big investment in rail over the coming decades will have to compete with other demands on government finance to deliver societal, economic, and technological benefit to the UK population.

If the rail industry wants cash for projects, it has to demonstrate that it can build a transport route that is on time, cost efficient and innovative, and which is something capable of delivering wider benefits to the community and that meet the government's broader objectives in a rapidly changing country.

We have to be clear about our needs and outcomes – understand the social impact not only as an indirect benefit of what we are proposing," she said. "The conversation need to move away from assets to citizens – understand their needs – turn those into outcomes and in turn outputs'.

"And we must be solution agnostic – heavy rail is not always going to be the answer."

In an industry that usually wants nothing more than to build a lovely, big new heavy rail scheme, that could be a hard pill to swallow. But as transport patterns change and



Trams might sometimes be better solutions than heavy rail

central government looks for reasons not to spend when there are huge demands on public spending, the rail infrastructure sector will have to be more flexible.

It will have to recognise that central government along with clients in local government or the private sector who

are looking to meet a transport need will be seeking cheaper but equally effective alternatives to major rail schemes. Those could be buses, very light rail, tram trains or rail projects that can develop in stages rather than as one grand project laid out from end to end right at the start.

"If we are dogmatic about heavy rail as a solution, and we don't seriously look at alternatives in this connected age, we are going to struggle as an industry. Enhancements are going to fall off the "can do" list and we will be just doing renewals by CP7 (2024-2029)," said Aecom head of rail for Europe, Middle East and Africa

“We must be solution agnostic – heavy rail is not always going to be the answer”

“I believe there is an opportunity for output-based procurement

Russell Jackson.

There are examples now of projects that are developing from mode agnostic positions. These include parts of Northern Powerhouse Rail where further use of the tram train now running between Sheffield and Rotherham is being considered alongside heavy rail. And in Wales options between bus and train are similarly being debated.

Other routes such as the Ashington-Blyth-Tyne (ABT) route in the North East are being allowed to develop in response to demand. On ABT a freight route is being reopened to passenger trains but the service plan is to start low frequency and then expand as passenger numbers and associated economic development increases.

Network Rail alliance director Dominic Baldwin points out that there are opportunities to start working with the supply chain on outcome- and output-based procurement linked to the various transport strategies set out around the regions.

Around the country there are now various 25, 30 and 40 year transport plans in place.

“If we are clear about the stages and outputs, and the incentives to hit each stage, I believe there is an opportunity for output-based procurement,” says Baldwin.

“If we don’t complicate things too much but break everything down and work collaboratively, it is possible. But collaboration is not worth anything if we don’t know what we want to achieve.”

At each stage, decisions and outputs have to be based on selection criteria that deliver the long term transport vision.

“If you don’t have selection criteria, decisions will never be made. And the criteria need to be right – for instance on High Speed 2 they are more about capacity than speed,” said director general for the resources and strategy

AT THE ROUND TABLE

This report is based on a round table debate supported by Aecom focusing on the need for rail schemes to be able to demonstrate improved passenger outcomes in order to guarantee funding. The debate took place during New Civil Engineer’s Future of Rail conference in June. Attendees were:

Dominic Baldwin, alliance director, **Network Rail**
Chris Curtis, head of Crossrail 2, **Network Rail**
Malcolm Dare, executive director commercial and procurement, **Highways England**
Shamit Gragier, director of strategic advisory, **Aecom**

Mark Hansford, editor, **New Civil Engineer**
Russell Jackson, head of rail, EMEA, **Aecom**
Nick Joyce, director general, resources and strategy group, **Department for Transport**
Ross Mackenzie, managing director, **Kier**
Jo Parker, West Midlands rail programme director, **West Midlands Combined Authority**
Mike Pauley, director advanced structures, EMEA, **Aecom**
Rikesh Shah, head of commercial innovation, **Transport for London**
Tim Wood, rail director, **Northern Powerhouse Rail**

FURTHER READING

- More on Heathrow Southern Railways proposal at heathrowrail.com
- More on Transport for Wales’ plans at www.newcivilengineer.com/latest/interview-james-price-transport-for-wales-24-07-2018/
- More on the Ashington-to Blyth-Tyne reopening at www.senrug.co.uk/Re-open-AshingtonBlythTyneLine.php

group at Department for Transport Nick Joyce.

“They should be about the benefits, that’s what we need to hear. The benefits are the value.”

There were calls for clients to think differently about procurement, even procuring in stages and definitely looking for new ideas.

“Before finalising a procurement brief, early market engagement should be used where possible to test and review different types of innovative solutions. This allows the client to be more informed prior to setting an outcome-based procurement,” said Transport for London head of commercial innovation Rikesh Shah

This will require the supply chain to embrace change.

“For the supply chain to continue to think in terms of big detailed design or big construction is the way of the dodo,” says Aecom’s Jackson.

“We have to broaden our capabilities, how we innovate, become trusted advisers to clients and create more ways of delivering design. This needs to include more modular construction, more automated design and more automated construction.

“A start, maybe, is to mandate use of modular techniques rather like was done 10 years ago with building information modelling.”

The importance of bringing in learning from other sectors including the tech sector is well understood, as is the need to come up with new sources of finance.

Heathrow Southern Rail, a privately financed proposal to link Heathrow Airport with Waterloo and connections south to Guildford and Basingstoke, has a board that includes leaders from Tideway, rail franchises and the financial sector which are sharing learning on financing and risk apportioning. Its proposal is currently with the government for assessment.

Land value capture will be used to help fund improvements on ABT as patronage rises with advice from potential developers about what to focus on.

Transformational change is a difficult challenge for the public sector however.

What is required are senior leaders who are able to discuss how to overcome potential blockages such as

High speed rail backers must concentrate on the benefits



traditional public sector procurement models.

Clients and the supply chain will have to work together to reassure public funders that accountability and transparency under new models would still be rigorous while making sure that for the private sector the risks will be clear, understood and manageable. **N**

“ If you don’t have selection criteria, decisions will never be made. And the criteria need to be right

HEATHROW SOUTHERN RAILWAY

Heathrow Southern Railway (HSR) is a privately financed £1.6bn proposal for a Southern Rail Link to Heathrow Airport.

The scheme is intended to allow fast, easy and relaxing access to Heathrow Airport through the construction of up to 12.8km of new railway from the west end of the existing Terminal 5 station, linking the South Western and Great Western rail corridors.

HSR would open up access to and through Heathrow from south west and south east England by enabling trains to operate between Heathrow and Waterloo via Clapham Junction, Putney, Hounslow, Twickenham, Richmond, Staines and other intermediate stations; and between

Heathrow, Woking, Guildford, Farnborough and Basingstoke.

Trains could set out on journeys to Heathrow from as far away as the south coast.

The government’s recent M25 South West Quadrant Study ruled out widening the motorway to improve access to the airport. HSR provides the alternative, switching traffic from the roads and contributing to improving local air quality. The promoters estimate that each year HSR will reduce the number of road journeys by around 3M and avoid the release of 2t of NO_x and 8,600t of CO₂ into the atmosphere.

Backers of the scheme will have to wait until the end of the year to discover from Department for Transport if the project will be taken forward.

PREDICTING THE FUTURE

A new design method that accurately predicts subgrade deformation under train loading helps demonstrate the benefits of incorporating stabilisation geogrids in trackbed design, saving time and money over the lifetime of a railway, says Tensar senior application technology manager **Andrew Lees**.

With growth of passenger rail journeys predicted over the next decade or so – Network Rail is forecasting an additional 1bn journeys by 2030 – and continued reliance on the network by industry for moving freight around the UK, there will be increased pressure on railway infrastructure in the coming years, especially in terms of track reliability and capacity.

Of course, trackbed maintenance work and line speed restrictions significantly affect schedules and are expensive and disruptive to the public, industry, train operators and asset owners. A lot of maintenance is aimed at rectifying poor track geometry and a loss of vertical and horizontal alignment of the rails, caused by subgrade and ballast deformation, which often leads to speed restrictions.



Mechanical stabilisation of sub-ballast layers using geogrids is a tried and tested approach that can reduce maintenance, by reducing traffic-induced degradation, slowing the rate of track settlement, maintaining track geometry for longer and extending ballast life tenfold (see box). In fact, maintenance intervals can be up to three times longer, reducing whole-life costs, in terms of cash and carbon.

However, while geogrids have

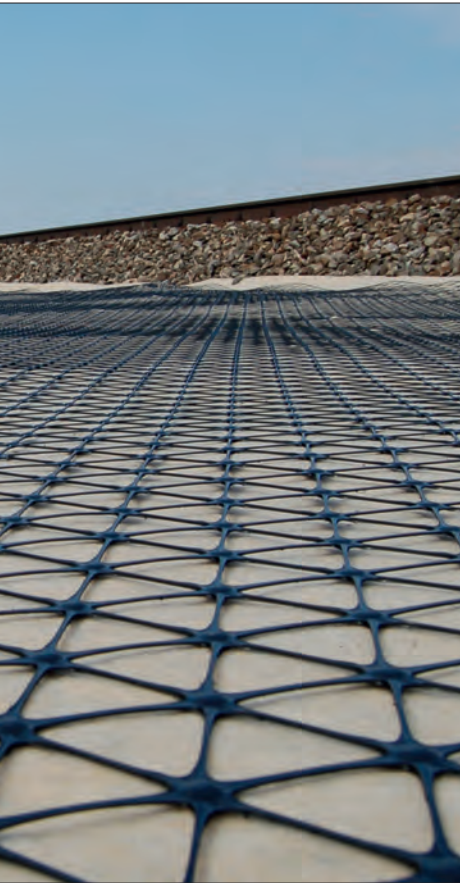


been used for decades in rail track construction, current performance-based design methods do not accurately predict long term behaviour of ballast, sub-ballast and the subgrade, which means their benefits cannot be truly modelled during design.

That is why Tensar International set out to resolve the issue, with the aim of developing a new design method that not only predicted track foundation performance more accurately but that would also allow the benefits of installing stabilising geogrids to be determined reliably.

The Li-Selig method is the common approach used in performance-based track design. This is used to predict permanent subgrade deformation, based on empirical relationships and analysis models developed in the 1970s.

Tensar's initial investigations using finite element analysis (FEA) with elasto-plastic constitutive models, instead of the linear elastic models of



the older analysis methods, highlighted some of the drawbacks of using this approach.

In particular, the team found that, compared with other input parameters, permanent deformations were not particularly sensitive to the stiffness of subgrade and ballast layers – which are key input parameters to the elastic layer analysis used in the Li-Selig method.

Furthermore, it was found that predictions were highly sensitive to the depth of the subgrade layer and the properties of the underlying soil layer, making an appropriate selection of the subgrade depth in the Li-Selig method almost impossible. As a result, the approach was found to rarely deliver an accurate prediction of trackbed behaviour.

In contrast, Tensar's approach uses advanced, but readily-available, hardening plasticity models to predict permanent subgrade deformations under train wheel loading. These

outputs are multiplied up by the more reliable element of the Li-Selig method that depends only on the subgrade soil type to obtain a prediction of the accumulation of subgrade deformation under successive train loading.

The method also includes a simple mobilised bearing capacity calculation for optioneering, rather than having to carry out a full 3D FEA, which can be time-consuming and expensive, if used on every design option.

Relationships have been derived between mobilised bearing capacity and permanent subgrade deformation that can also be multiplied up to obtain approximate predictions under successive train loading. Once the preferred option has been chosen, a full FEA model can be run.

Tensar's new approach was calibrated with its TriAx geogrid, using laboratory testing carried out at the Czech Technical University, with 500,000 load cycles on rails and sleepers supported by stabilised and non-stabilised sub-ballast over a clay subgrade.

Data gathered by Tensar and its research partners during full-scale field trials of geogrid placed in sub-ballast on live freight and passenger lines in Slovakia, the United States and South Africa was used to back-analyse, and confirm, modelling predictions.

Lower quality materials (such as fouled ballast) stabilised with TriAx were also tested, and it was found

Geogrids can spread train induced loads more efficiently, reducing track settlement by as much as 40%

that their stabilised mechanical properties exceeded those of non-stabilised, higher quality materials. This could have a major positive impact on costs and sustainability, as it enables re-use of fouled ballast materials as sub-ballast, in both track construction and in rehabilitation.

With an ever-increasing burden being placed on rail infrastructure, there is clearly a need to deliver safe permanent way efficiently, with designs that offer value for money (in terms of both construction and whole life costs) and that have minimal environmental impact.

This essentially boils down to mitigating risk – a large proportion of which lies in the ground. Of course, it is incredibly difficult to predict every possible situation arising during construction and operation but more accurate modelling, which enables track engineers to design to actual ground conditions, can deliver more appropriate solutions, mitigate risks and ultimately add more value.

To that end, this new design approach enables designers to more accurately predict long term subgrade deformation and to model the benefits of incorporating stabilising geogrids into sub-ballast. This should save time and money during construction and over the operational lifetime of a railway, through longer maintenance intervals.

● **Andrew Lees is senior application technology manager at Tensar International, specialising in the application of numerical analysis to solve geotechnical engineering problems.**

STABILISING GEOGRIDS: THE BENEFITS

Geogrids have been used to stabilise track ballast, sub-ballast and the subgrade beneath railways since the early 1980s.

When granular fill material, such as ballast or sub-ballast, is compacted over a geogrid, it partially penetrates and projects through the geogrid's apertures to create a strong and positive interlock. This interlock enables the geogrid to confine and restrain the granular material from lateral spread, which helps maintain horizontal and vertical rail alignment.

Laboratory and field testing has shown that sub-ballast layers stabilised by geogrid are better able to distribute imposed traffic loads, by

increasing the area of influence on the subgrade, so bearing pressures are lower.

By providing a stiffer foundation to the track, settlement has been reduced by almost 40%, for the same amount of rail traffic, compared with non-stabilised sub-ballast layers. These layers can also be up to two-thirds thinner, while maintaining bearing capacity, reducing excavation and replacement of weak subgrades, cutting construction time and costs.

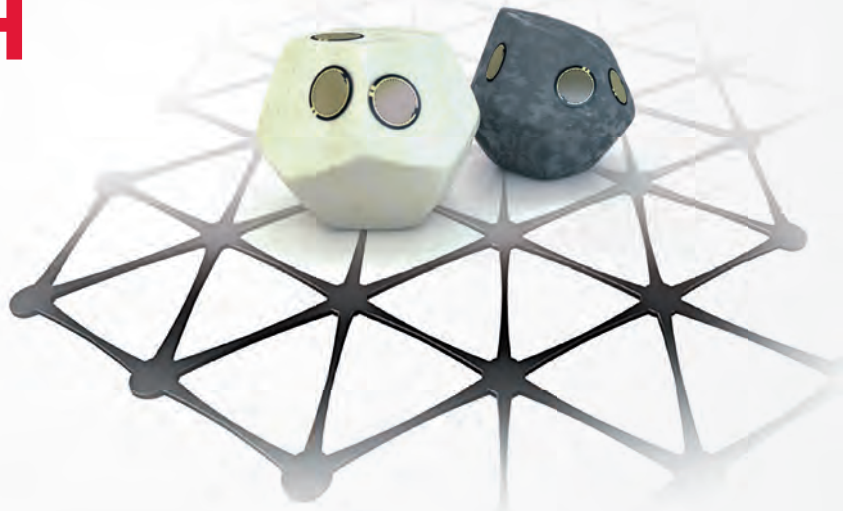
Track profiles can also be smoothed at interfaces between structures, for example where embankments meet concrete trackbeds beneath overbridges and in tunnels, by reducing the effects of differential settlement.

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Visit tensar.co.uk/smartrail to see how our pioneering research demonstrates that ballast stabilised with TriAx® maintains track geometry, reduces settlement and extends maintenance cycles.

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Innovative Thinking

NEW DESIGN CONCEPTS, INVENTIVE CONSTRUCTION METHODS AND FRESH IDEAS



From the incredibly intricate excavation of a deep five storey basement beneath London's Claridge's hotel, to efforts to power the UK rail network with solar energy, engineers are pushing new boundaries

CLARIDGE'S CAVERNOUS CREATION / PAGE 54

RIDING SUNBEAMS IN RAIL / PAGE 62

GEVE: AN SME RETHINKING ENGINEERING / PAGE 64

REIMAGINING CLARIDGE'S

One of the most remarkably intricate, innovative and unique ground engineering projects has been happening at a London Mayfair hotel. **Alexandra Wynne** explains why it has been so extraordinary.

If the walls could talk at London's iconic Claridge's hotel they would probably be able to tell the juiciest of secrets – from being at the heart of the roaring 1920s scene to hosting world dignitaries and supermodel Kate Moss's 30th birthday party. The hotel has seen it all. Now, thanks to an extraordinarily complex five floor basement extension, some of its closest held secrets have been revealed.

Originally the expansion plan was far more modest. In 2007 the Maybourne Hotel Group was in discussions with contractor McGee's managing director Jim Mackey about a bold new two storey extension to its highly valuable asset. During the tender process Mackey's bid had emerged as winner and was the only one defiantly pledging to keep the hotel open and guests undisturbed during construction.

But the 2008 economic downturn hit and, as was the way with many ambitious projects, plans were shelved. Fast forward to 2015 and a now retired Mackey got the call he knew would be too difficult to ignore if and when it came – the project was

KEY FACT

£37M
Cost of the project

4.7m
Storey height

5,000t
Material excavated for each level

5
New basement levels

1929
Early reinforced concrete raft built

“There was a day when we were almost at a showstopper

being taken off the shelf, and would he lead it? Only, just to add a whole other dimension, the client now wanted a five storey basement.

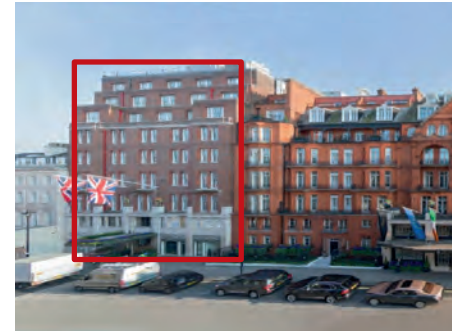
“It's fair to say that what we imagined at concept stage [in 2007] was dramatically different in 2015,” recalls Mackey. The idea behind the change was that to truly retain the hotel's crown as among the city's finest, it needed to build a new spa, 20m swimming pool and cinema facilities as well as moving space-consuming plant from the roof to release valuable opportunities to create 40 new guest rooms with prime new penthouse suites among them.

It was action stations on the circa £37M design and build contract to create the new space beneath the Grade-II listed building and McGee invited consultant Arup to advise on geotechnics and structures. At this

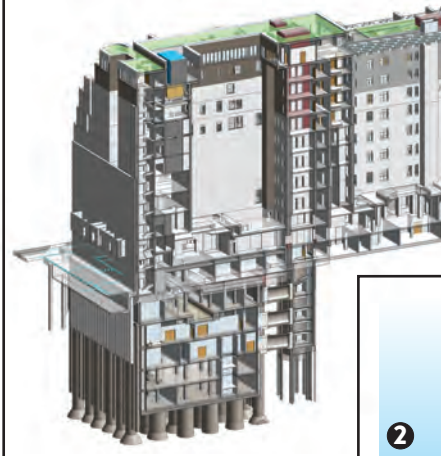
CLARIDGE'S



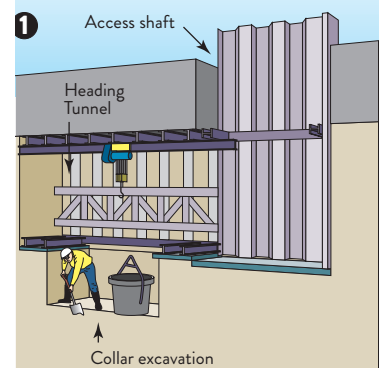
CLARIDGE'S BASEMENT EXTENSION SITE



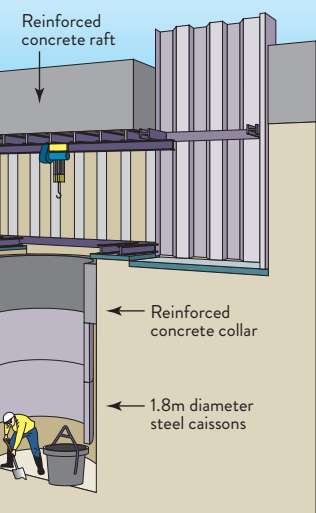
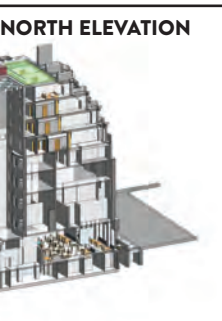
FINISHED BASEMENT: SECTION THROUGH



HAND DIGGING THE SHAFTS TO FORM 61 COLUMNS



BASEMENT



5,500m²

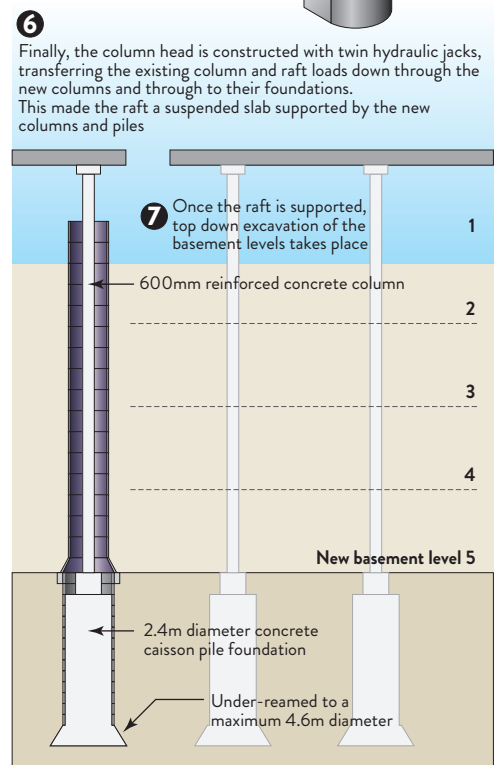
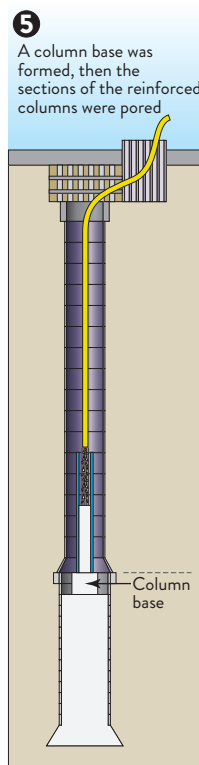
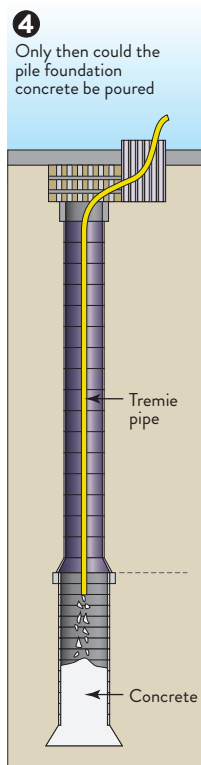
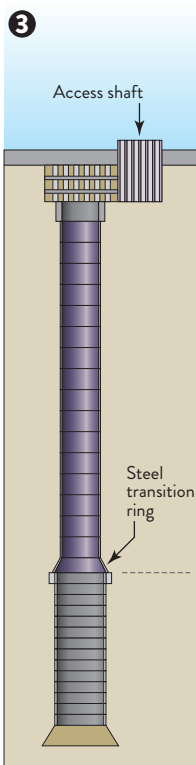
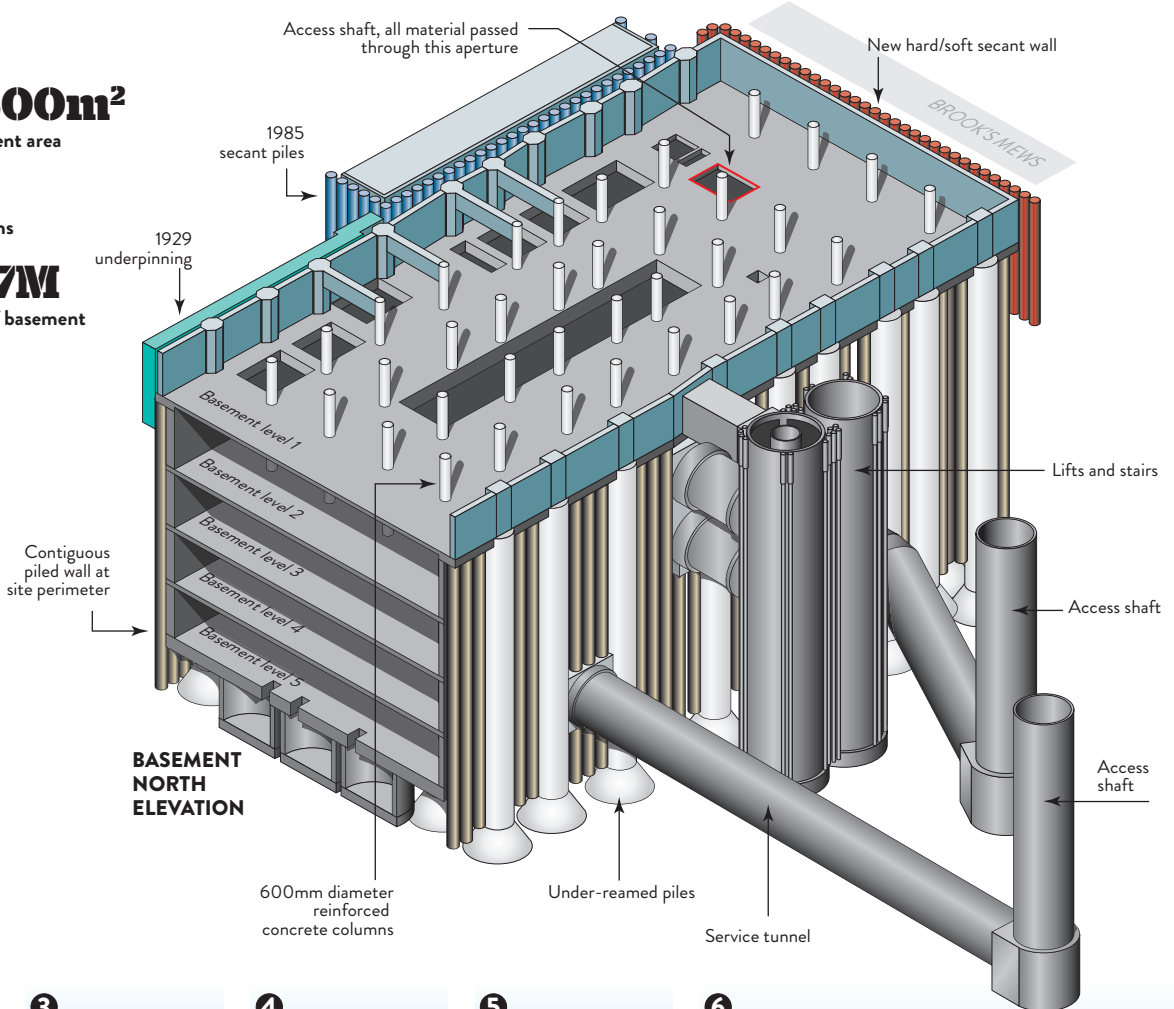
Basement area

61

Columns

£37M

Cost of basement



“Initially there was a lot of thought around how is Jim going to be building this

point there was “much meat to be added to the bones” of his concept, explains Mackey.

Almost immediately in autumn 2015 the discovery of perplexing ground conditions threatened to put the project back in limbo.

“There was a day when we were almost at a showstopper,” Mackey reveals.

“The original concept was based on the idea we had water-bearing gravel underneath the raft and we would use traditional, conventional techniques to [grout] inject it to stabilise – in reality it was a dense silty, sandy clay material.”

The reinforced concrete raft foundation is at the base of the 1920s Art Deco wing of the hotel, which lies to the east of, and adjacent to, the hotel's 1890s Victorian wing at the corner of Brook Street and Davies Street in Mayfair. The former was the site for the basement extension and it drops a storey height from Brook Street to the north to Brook Street Mews at its southern elevation.

The concept had been to tunnel beneath the existing reinforced concrete raft supporting the Art Deco wing through grout injected soil; driving shafts from these tunnels down into the London Clay below before casting new columns to enable top down excavation of basement levels one to five.

Adding to the underlying soil's unusual composition is the proximity of the underground River Tyburn, running along the alignment of Avery Row, east of the site which also drops from north to south.

Arup geotechnics director Dinesh Patel describes the highly unusual material as like a saturated flour going to a sand with some clay content and with similarities to pulverised fuel ash



Excavating basement level one revealed the underside of the 1929 reinforced concrete raft

(PFA). The strata was also irregular in another way – forming a “wedge” ranging from virtually nothing at the north boundary to between 1.3m and 1.4m thickness in the south.

“At one stage, without wanting to over exaggerate it, we were thinking this job is not going to happen; we're not going to be able to do this,” Mackey continues.

“Dinesh and I scoured the whole of Western Europe and beyond and met the great and good of the grouting fraternity to explore every possibility; only to come up empty handed.”

Mackey, Patel and their teams were not ready to walk away and embarked on finding answers – the McGee and Arup offices soon hosted some on the fly soil testing.

“We had a small quantity of this material that we effectively dried out,” explains Mackey. “I put mine [in a mug] on the shelf near the window in the summer sun for a couple of days, only to find when I returned to it, it had solidified. From that fairly basic experiment we now knew that if we could get the water out then we could change the properties of this material such that we could excavate tunnels through it.”

Patel adds: “It's a bit like building a sandcastle. When [the sand] is dry you can't build a castle, but when it's wet you can because the surface

tension between the particle sizes is trying to keep the particles intact. So drain out just enough water and it goes into surface tension, the particles stay intact and you can build the sandcastle.”

At this point specialist dewatering contractor WJ Groundwater was working for the project and, along with Patel's prior experience of dewatering PFA, a complex but achievable plan was formed to make the material workable for mining works to begin (*see box*).

“So we completed the design of our heading frames with a mock up in our plant yard ... and we manufactured enough frames for what would be our first heading,” says Mackey.

Helping to keep the project's momentum while the full results of the dewatering had yet to be realised was the support of an open-minded client, in particular Maybourne major shareholder Paddy McKillen, whom Mackey describes as “absolutely fantastic” and “very pragmatic” in his trust of the engineers and in agreeing to release funds to enable progress to be made.

By mid-February 2016 the silt had begun to dry out to the point where the team was confident that the excavation plan would be successful.

Perhaps on another scheme on another day that would be the

DEWATERING THE GROUND

“You can’t simply suck water out of this material. You really need to find another way”

Tests of the saturated alluvial deposits under Claridge’s revealed that while it was akin to soupy porridge at first, taking out just 3% or 4% of the moisture content increased its strength to something that is excavatable.

But drawing out the water was a challenge.

“You can’t simply suck water out of this material that’s like a dense sponge when it’s holding all that water,” says Patel.

“You really need to find another way, which is to vacuum out the very small space between the flour-like elements to remove the water.”

“Although sloping from north to south, the layer of permeable gravel was pretty consistent over the site,” adds Mackey.

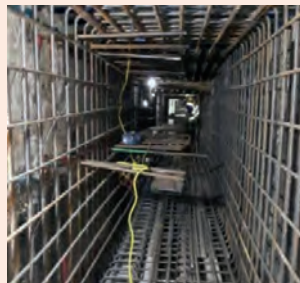
“By putting the dewatering wells in the permeable layer we could draw from that layer and that provided a reservoir for the silt to drain into.”

Cutting off the water was another issue as water threatened to recharge the site all around its perimeter. At this point WJ Groundwater’s Toby Roberts was a key player, Mackey points out.

Revealing more of the building’s secrets also signposted the way ahead. The east and west were helped by historic ground works.

Among them was a Larssen steel sheet piled wall installed along the entire length of the western elevation in 1929 to facilitate the excavation for the Art Deco raft.

The east flank had a



Installing water cut off beam

combination underpinning, again for the raft excavation, on the northernmost section leading to a secant piled wall in the southernmost area, installed in 1985 (see drawing).

Site workers installed a new hard/soft secant piled wall along the southern elevation where the concrete raft extended 2.4m into Brooks Mews.

They then dug down at the each end and sealed the secant piled wall onto the sheet piles at the west and to the original secant wall to the east creating an effective water cut off around three sides of the site as well as an earth retaining structure for the eventual basement construction.

More difficult was the north boundary, exactly where the front entrance to the hotel lies.

“To the northern elevation it was much more complex because now we’re virtually at the front door of the hotel and the client is saying ‘I don’t want to see any excavators or piling rig or bentonite sloshing around the front door,’” says Mackey.

The solution was to install a 1.2m wide, 1.8m high and

25m long water cut-off beam, working from some very restricted pavement light wells and storage vaults beneath ground level into the building.

“What we ended up doing was making effectively what was a small northerly extension to the raft and the idea was then that we could then subsequently underpin it and create the vertical earth retaining system to get us down to basement level one,” says Mackey.

This was again tied into sheet piling and the existing underpinning this time, completing work to mitigate water ingress.

There remained some concern that success would be limited to the area around where the wells could be installed.

“In normal vacuum dewatering there should have been a series of wells over the entire footprint,” Mackey explains. “Of course we’ve got this one room [in the lower ground floor of the hotel]. The big \$64M question was: are we going to put in this dewatering in a little room and a few outside in the street and will that just dewater 4m or 5m around it and all the rest stays fully saturated? There was a bit of an unknown quantity in that respect. But we thought we’ve got to run with it.”

The team’s efforts were rewarded and within days the saturated material began to dry out and become semi-coherent, enabling mining works to begin.

“We realised at the time that this concrete was not behaving like a reinforced concrete raft

epitome of the technical challenges. But the intricate and complex old buildings meant more hurdles still to be conquered.

The Art Deco building is supported by 64 steel columns resting on the raft, which is one of the earliest examples of a reinforced concrete slab of its kind. As there was no precedent for the plan to excavate tunnels beneath such a structure, the team began to reveal more of the building’s secrets.

“This had never been done before,” says Mackey. “You’d imagine with such an iconic building – and one that’s not necessarily that old, there’d be a decent archive.” But the team found the “archive” merely consisted of a one-page article from a 1931 issue of *The Builder* magazine, confirming the thickness of the raft. But there were two pieces of information that were “extremely useful” – that the total reinforcement content of the raft was 75t and there were sheet piles all the way along the western elevation.

“We realised at the time that this concrete was not behaving like a reinforced concrete raft – it wasn’t designed to current standards,” Patel points out. “It had some brittleness”, likely because the reinforcement bars were spaced more widely than today’s design would have.

Patel and his team continued to evolve a plan to ensure any distortion was intricately monitored to prevent cracking as voids through the stabilised material were opened up during tunnel excavation.

“We didn’t know how much movement we’d get from this operation because you can’t do a simple set of calculations,” says Patel.

“Initially there was a lot of thought around how is Jim going to be building this. How do we actually model that and analyse the movements? Because we needed to



PHOTO: NICK CARTER

“There are 64 columns in the building and we’ve only had to install 61 as the other three are picked up via transfer structures

know how much distortion will it cause to the raft before you secure it with lots of columns. Once you secure it with columns and foundations, the raft becomes a suspended slab.”

In reality, movement was minimal and all the while the dewatered material was gaining strength, turning from a liquid state to being semi-cohesive in two weeks.

The first 2m by 2m frames were installed to complete the first heading and as the ground improved, anchors that had been introduced to mitigate face loss, and the resulting potential strain on the raft, were able to be scaled back to the delight of the

whole team, which by now included temporary works designer RKD Consultants.

Extraordinary planning for temporary works and the permanent structural build were a large part of Mackey’s concept for keeping the hotel operational and undisturbed. Initially a small window from the southern access was available followed by a tiny 2m² aperture cut in plan into, and dug 2m down below, the raft. All excavated material, all supplies, and perhaps more remarkably all equipment, had to be brought in through this rear window and raft aperture. The limited access and storage space also required a “just in time” delivery regime.

A carefully choreographed plan required 400m of tunnels – shorter adits running between three longer parallel tunnels running east to west – more familiarly referred to as Tom, Dick and Harry after those by the same name in the film “The Great Escape”. From these, shafts could be dug to form 61 columns beneath the raft.

“There are 64 columns in the building and we’ve only had to install 61 [beneath the raft] as the other

The pile base is under-reamed out to 4.6m diameter

three are picked up via transfer structures,” says Mackey.

The first columns were installed to form a cruciform shape in plan around the slab aperture. This enabled workers to open it to a more generous 3.1m by 3.8m.

Following a carefully planned sequence, where no two adjacent columns could be worked on simultaneously to again avoid destabilising the raft, site workers installed 1.8m diameter temporary circular steel caissons – the maximum diameter Arup deemed feasible below the old raft – in sections to depths up to 30m below the raft into the London Clay.

The size of these caissons highlights yet another challenge facing the team in resolving a tension between the appropriate column design and buildability. Patel explains: “Ideally our teams would have wanted a 900mm column or a 750mm column but that wouldn’t be possible in the current situation that we had.”

As Mackey points out, the chosen 600mm diameter column already left very little room for miners to work in to form the permanent columns.

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“This job was not for the faint hearted and not for one without experience

The 1.8m external diameter of the steel shaft translated into a 1.7m internal diameter when flanges were taken into account, and a 600mm diameter column became 700mm in diameter when formwork was included. That left just a 900mm diameter workable space within the shaft, which in reality was a mere 450mm between the internal edge of the shaft and the outside of the column. This was just enough to safely get the columns installed.

The design is driven by buildability,” Patel asserts. “This job wouldn’t have happened without Jim’s experience.”

“But [600mm] diameter wasn’t going to be anywhere near big enough to deal with the end game loads here,” Mackey continues.

So to make the loads work, the shaft stepped out at the new basement level five to accommodate construction of 2.4m diameter concrete caisson pile foundations to varying depths, depending on differing column loads and the level of the clay at each location. These piles were then under-reamed out up to a maximum 4.6m in diameter.

A tremie pipe installed at full depth of the under-ream aided concreting of the foundations up to the lowest basement level.

Coupling of steel reinforcement bars in small sections enabled their passage through the small aperture and down into the inner steel caissons before concreting works formed the 61 new columns.

After removal of the steel caissons temporary bracings stabilised the now otherwise free standing columns.

Finally, twin hydraulic jacks at the top of each column transferred the existing raft loads down through the new columns and through to their foundations.

This made the raft a suspended slab supported by the new columns and piles.



The extraordinary basement extension makes space for new spa facilities which include a 20m-long pool

Work then turned to installing a contiguous piled wall acting as the vertical earth retention system that would enable top down excavation from basement levels one to five.

This reinforced contiguous piled wall had to deal with “enormous loads”, says Mackey, and the Arup team did “amazingly well” to get them down to 750mm diameter.

Nevertheless, rigs small enough to work in the tight, 4.5m headroom space and capable of driving such a large diameter were unavailable.

McGee had an Italian rig with a 7m mast in its fleet that was the closest to fitting the bill. However, it was diesel-powered and the risk of exhaust fumes entering the in use hotel was just too high.

Mackey recalls: “We took our rig, we brought people from Italy over [from the manufacturer]; we redesigned the mast; we built a new Kelly bar; we had a new mast made; we ourselves converted it; we took out the diesel engine and put in an electric motor. We then dismantled it into 12 bits and trundled it down the access and in through the window.”

A massive effort to convert or source non-diesel powered tools, electric excavators and dozers was undertaken throughout the project on an unprecedented scale.

With the contiguous wall installed, miners could excavate the 5,000t of material from each 5,500m², 4.7m tall

basement level, casting floor slabs as they progressed down from levels one to five.

In what was one of the more straightforward aspects of the programme, and with extraordinary management, Mackey’s team saved four months on the schedule.

“Without Jim’s foresight and understanding of the industry gathered over 40 or 50 years – a long time, this job wouldn’t have happened,” Patel enthuses. “This is why the job is unique. You can’t turn this job into a project management job or a construction management job. There are no construction managers or project managers here, it’s just Jim doing all those roles and taking on the role of builder. The design is really driven by its buildability, not the other way around.

“It’s not design and build; it’s build and design. This job was not for the faint hearted and not for one without experience.”

Two key challenges remained. While the new basement included a lift for guests through the Art Deco wing, it would be a long walk through the Victorian wing to access all the new facilities. So the team had to excavate two large 4m diameter shafts below the Victorian wing which houses kitchens and wine cellars. All work had to happen in the dead of night with material excavated and removed with wheelbarrows through corridors, and then cleared up every morning. Once site workers had cast the slab and completed basement level five, two 3m walkway tunnels could be driven out to meet the shaft.

Work on the basement and the around £3M contract for the service tunnels and new vertical transportation shafts was completed early this year. The hotel is now in the throes of a major refurbishment throughout with contractors fitting out the new lower levels and top floor bedrooms.

As *New Civil Engineer’s* visit drew to a close, the underside of the original raft – in all its uneven glory – hints at what the construction team had to deal with. But for the new guests, trying to imagine what it took to deal with the saturated ground while they take a swim in the new pool, will be hard to do. **N**

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RIDING THE SUNSHINE

Solar powered trains could be the solution to the challenge of decarbonising the rail sector. **Katherine Smale** reports on a truly exciting trial.

Holidaymakers travelling from London to Weymouth this summer may not know it, but the train they are travelling on could be one of first ever powered directly by solar energy.

The “first light” trial, funded by the Department for Transport and Innovate UK to directly power trains via around 100 trackside solar panels at Aldershot in Hampshire is currently underway.

Should it be successful, it could pave the way for the world’s first ever full-scale rail network solar traction farm by 2020.

The pilot, a collaboration between Network Rail, climate change charity 10:10 Climate Action and Community Energy South is the latest chapter in a story which started back in 2014. Then, in a field next to a set of tracks, a revolutionary new idea for a decarbonised railway was taking shape.

10:10 was trying to find a location to connect to the grid for a new community-owned solar farm in Balcombe, Sussex. No connection was possible, but instead there were multiple connection points to the

KEY FACTS

100
Number of
trackside solar
panels being
installed on
the London to
Weymouth line

“We’ve got to find out how the solar photovoltaics generation interacts with the power systems on the rail network

railway all along the length of the line.

Fast forward five years and the Riding Sunbeams project to power around 10% of the UK’s electrified railway lines with solar power inputted directly into trackside infrastructure is becoming a reality.

The concept is simple. Instead of inputting into the grid, small solar farms along the route of a railway line input their power into the railway, bypassing the grid.

This results in lower rail operating costs and lower carbon emissions, while bringing new opportunities to the renewable energy market. An added benefit is that the solar farms



are run by the local communities, with profits being ploughed into schemes which benefit the surrounding areas.

“The first thing we’re going to build is a proof of concept,” says Advisory Services Energy consultant Ernie Shelton. “We’re starting very small as we’ve got some lessons to learn. Whilst we’ve done a lot of analysis it’s another thing to put that into practice to see if your sums were right.”

Spearheaded by 10:10 and the Energy Futures Lab at Imperial College London, the Riding Sunbeams project has already undergone a feasibility study. Although the process is moving forward, 10:10 director of innovation Leo Murray says it has had its fair share of technical challenges.

In the UK around 5,200km of the 16,000km rail network is electrified, with Network Rail being the largest electricity consumer, using around 1% of the national supply to power trains on the network.

Of the 5,200km, around one third powers trains through a direct



current (DC) third rail connection, with the remaining two thirds powering them alternative current (AC) overhead catenaries.

The team decided to focus on the DC third rail networks as they have the infrastructure to connect to small solar farms at regular, relatively short spaced, 2km intervals.

Power connections to the overhead AC systems are often more than 100km apart.

The aim was initially to create a direct solar generated DC supply to traction substations on the DC rail network. But inverters are needed to create the connection and these not exist on the mass market. New, bespoke, equipment would have taken years and millions of pounds of research and development before they can be deemed safe to use by Network Rail.

Connecting directly to the substation would also have required an energy storage system so that power could be produced to match the intermittent demands of train services and the intermittent

Using the sun to power trains will reduce pressure on power supplies and reduce rail's carbon footprint

generating ability of solar power.

Again with the immature nature of storage technology in the rail industry, this would have led to delays in the process.

These factors led the team to develop a new "pragmatic" alternative solution. Working with Network Rail, the team will now connect generated DC power into the 33kV AC feeder systems that carry power from the grid supply points to the 10 to 15 substations they feed.

Although the DC to AC and back to DC connections can lead to some losses, there are a number of practical advantages. The equipment needed is freely available and can be repurposed from other applications bringing down the cost.

The current trial will involve connecting a small array of around 100 solar panels to an ancillary transformer on the Wessex Route's traction system that controls signalling and lights.

It is hoped that the trials will show that the plugging in directly can be done safely and without

“We’ve been speaking to High Speed 2 Ltd, with conversations about why you should do this

disrupting the trains.

“We’ve got to find out how the solar photovoltaics generation interacts with the power systems on the rail network and that’s one of the first and one of the biggest challenges,” says Shelton.

Although the technology is in its infancy, Network Rail director of route asset management for the Wessex Route Stuart Kistruck said it was ambitious to roll it out further across the network.

“Should this demonstrator project prove successful, we can deliver a greener, better railway for our passengers and the wider public.”

If the trial proves successful, six community-owned solar farm sites near to railway lines in the south of England have been identified as pilot sites where the new concept will be trialled.

Building on this ambition the team is already looking to the future.

In another boost to the project, Transport for Wales has also made a pledge to build renewable energy into its plans to electrify the railway lines north of Cardiff. It has awarded a £110,000 research grant to the Riding Sunbeams project to investigate its technology further.

It is hoped that the electricity for the routes, dubbed the “Green Valley Lines” will be 100% renewable with at least 50% of that generated in Wales.

Although the Riding Sunbeams project has so far dismissed retrofitting into the AC network, Murray says it is important not to write off plugging into the overhead catenary systems for future projects.

“There are problems with plugging into the existing AC network, but integrating it into the design where routes are going to be electrified – that does look like it could be done,” says Murray. “We’ve been speaking to High Speed 2 Ltd, with conversations about why you should do this.

“On its network, the power draw is absolutely eyewatering and extraordinary, so it would be great to have an impact on that.” **N**

BUILDING SUPPORT

A new software start-up is aiming to change the way engineers and the public communicate. **Connor Ibbetson** finds out more.

With 6M Londoners taking a bus journey in the capital each day, managing the interface between engineering projects and the public is a huge task.

And while the traditional consultation methods via exhibitions and leaflet drops are still used in the main, a tech start-up called Geve is aiming to take lessons learned from major projects and drive a step-change in communications between engineers and the public.

Geve's flagship work is Spatial Messenger, an app-based platform which will allow people to report incidents and problems with construction, congestion, and near-accidents to inform future projects. The app is being developed as part of the Transport for London RoadLabs innovation programme.

User reports – or pins – are tagged to a geographic location and can be supplemented with photographs and documents. The pins are automatically assigned to whoever is responsible for that area, be that a transport operator or construction

KEY FACTS

£150k
Geve's annual turnover

project manager. They can then view this information and respond directly to the user in a WhatsApp-style conversation.

The pins can also be viewed in the 3D-rendered environment allowing designers or project managers working miles away to accurately visualise issues raised on site.

The technology is the brainchild of Geve's founders, Richard Johnston and Mark Beckett, who set up the company in 2016.

Geve blurs the lines between the real and digital worlds, using software developed for the video game industry coupled with an engineering pedigree to build immersive 3D environments and cutting-edge interactive mapping for large-scale

“Mark has a great ability to pick information up and visualise it



civil engineering projects.

Johnston started work at just 16 and worked his way up to become transport director for the Olympic Delivery Authority (ODA) for the London 2012 Games, covering the major developments in and around Stratford.

It was here that the founding ideas for Geve were formed.

“The primary problem with the Olympic Park was that it was built on old railway land and before we could start on the stadium, we had to get all that old rail out of the way,” says Johnson.

“What I didn't have was a visibility of what was going on around Stratford. I needed to understand what was going on at a programme level quickly to meet our timelines. I advertised for someone experienced in data, GIS and CAD who could simplify what was going on across the entire project in a visual way, so I could present this to the other ODA programme directors and we could decide what was critical.”

The someone who got the job was Beckett. With two years at Transport for London (TfL) drawing up road and rail maps under his belt, he joined the



“We felt the first phase of any project should be explaining why we are building stuff”

ODA to produce maps of the park, before moving over to Johnston’s team.

“Mark has a great ability to pick information up and visualise it, and at this stage it was just 2D mapping.

“It wasn’t interactive or 3D, but it enabled us to focus in on key areas needed for delivery,” says Johnston.

“The mayor was concerned about the routes people would be taking into the city to see the Games, so I was asked to draw up the maps and transport plans for the whole of London, Beckett adds.

“But I thought to myself that not everyone was being engaged when it came to the traffic plans, and that’s where I started thinking that we should be asking local people how these plans will affect them.”

It was this concern over end user engagement which now is now part of the Geve ethos.

After the ODA, the duo headed off to High Speed 2 (HS2) Ltd, where they continued to learn lessons about how a dialogue between the public and engineers can help projects.

During one local consultation meeting, a local landowner produced historical geographic

Geve’s co-founder Richard Johnston and Mark Beckett

information about the sites of former quarries along the planned route of HS2 in his area, information that the engineers at had not encountered until then.

This highlighted to Johnston the flow of information in both directions was vital and would, again, go on to influence the creation of Geve.

For sections of HS2 phase two, Beckett took the plans for the rail route, and overlaid these with boundaries of parish councils, so Johnston could relay exactly to the right people what was going to happen in their area.

In this way Johnston says, local councillors were, in a way, incorporated into the design team by providing quality feedback through this better engagement.

The maps, models and drawings Beckett created were easy to understand at a glance but also contained all the information an engineer would need from a detailed plan as well.

“Everyone should be involved. We needed an interface that everyone could see,” says Beckett.

“This why we felt we could not be part of a major project – but advise

major projects instead.”

The result of Johnston and Becketts’ work was better communication with the public at a personal level. Objections to the second phase fell by 80% to just 187 compared to 2,500 objections to the first phase.

With their time at HS2 at an end the pair set out on their own with their lessons learned, combined with Beckett’s passion for gaming, to found Geve.

London-based Geve believes allowing the end user to see a completed project in virtual reality can help it understand the impact a project will have, and in return provide better quality feedback to engineers.

“We decided early on we needed another way of communicating information and receiving information. Our aim was to generate information usable both within the project and beyond with the public,” says Beckett.

“We felt the first phase of any project should be explaining why we are building stuff, who it is going to help. Our aim is to show how civil engineering can help people’s lives.” **N**

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TRANSPORT HYDROGEN TRAINS TO REPLACE ELECTRIC ONES

Hydrogen powered commuter trains could replace the need for electrification on smaller routes, Railway Industrial Association decarbonisation task force technical director David Clarke has claimed. Speaking at the *New Civil Engineer* Future of Rail conference, Clarke said the fledgling technology could be an alternative to electrifying smaller local rail lines. Clarke said that under incoming net-zero carbon rules, around 3,400 locomotives would require retrofitting to run on a different energy source, or have their emissions offset. In total, Clarke said 30% of the UK rail fleet could be suitable for running hydrogen trains.

STRUCTURES OFFSITE HUBS NEEDED TO KEEP HOUSING WORK ON TRACK

The UK will miss government housing targets without an increased adoption of modern construction methods, including offsite construction, according to MPs. The House of Commons housing, communities and local government committee report *Modern methods of construction*, urges ministers to invest more in developing offsite construction. It says ministers should track how much public housing expenditure goes into the development of modern construction methods.

ENERGY FIRST OF ITS KIND HYDROGEN TEST FACILITY OPENS IN THE UK

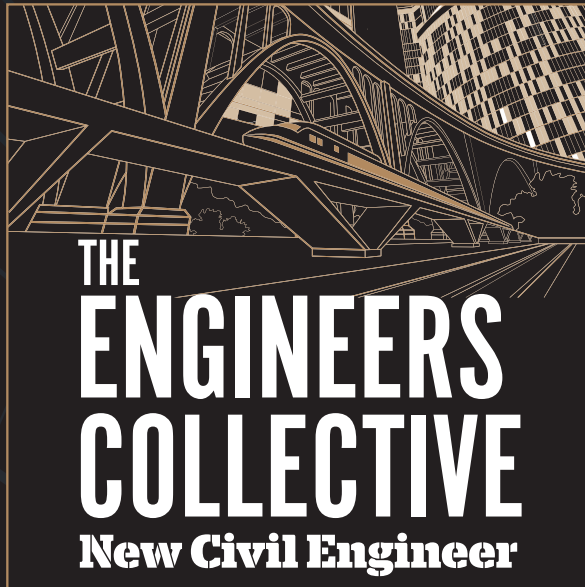
The world-leading H21-run facility has officially opened. It will examine ways to heat homes and businesses with hydrogen gas, and is the first such facility in the world. The site, at the Health & Safety Executive's science and research centre in Buxton, will seek to demonstrate that a 100% hydrogen gas network is equally as safe as the existing natural gas one. Burning natural gas to heat homes and businesses accounts for approximately a third of the UK's carbon emissions.

TRANSPORT HIGHWAYS ENGLAND TRIALS ELECTRIC ROADWORKS VEHICLES ON THE A14



Highways England is trialling two fully electric powered roadwork vehicles for the first time, as it carries out upgrades to the A14. The trial is part of a package of air quality measures to improve air quality along

motorways and trunk roads. The five month trial is being funded from the organisation's £75M ring fenced air quality improvements fund, which it intends to spend in the current road investment period.



The Engineers Collective is the new monthly podcast from New Civil Engineer that will debate and discuss the month's hot topics and explore with a special guest how key sectors must evolve in order to meet the needs of clients and society.



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STRUCTURES

Members urged to back building safety proposals

The ICE is urging members to support new safety reporting proposals by responding to a Ministry of Housing, Communities and Local Government consultation.

As part of the response to the Grenfell Tower fire in 2017, the ministry has published a consultation document seeking views on proposals for a new building safety system, including safety reporting for fire and structural safety issues.

These will build on the existing Confidential Reporting on Structural Safety (CROSS) scheme, which is part-sponsored by the ICE. It collects and reports on structural safety issues and shares lessons across industry.

The new proposals would expand and strengthen the existing CROSS scheme to include the collection of more voluntary reports, including those on fire safety issues. There would also be a new mandatory system for key dutyholders to report fire and structural safety issues to the building safety regulator.

ICE knowledge director Nathan Baker said: "Effective safety reporting is crucial to assuring society that infrastructure professionals can be trusted. Member support for the new proposals will help secure the funding necessary for strengthening and extending CROSS. We encourage members to respond to the consultation."

The deadline for responses is 31 July.

● Visit the ICE website for detailed guidance on the consultation and how members can respond.

DIVERSITY VIEW

GROWING CONTRIBUTION



Kyle Clough

In my last column, I discussed the importance of National Apprenticeship Week and its role in attracting people into the industry. I am pleased to say that plugging the skills shortage gap through apprenticeships is

beginning to yield results.

It is gratifying to see that when government, clients, contractors and Professional Engineering Institutions pull together, we can start to make things happen. That is why I'm delighted we are now recognising the importance of having a diverse workforce and providing wider career opportunities for people.

It has long been accepted that encouraging a diverse workforce in engineering is vital when it comes to increasing the industry's talent pool, as well as improving the industry's performance.

Within this diverse workforce, it is still the case that only 12% of professional engineers in the UK are female, according to the 2018 statistics from Engineering UK. But to encourage the increase in female engineers purely to fill the skills gap is to overlook a fundamental benefit of a more gender-balanced workforce.

Think about who uses infrastructure – everyone, from every part of society. Historically our infrastructure has largely been designed and built by men. But looking at infrastructure design and planning through a different lens can highlight issues that may perhaps not have been obvious in the first instance.

ICE's *What is the city but the people?* report from last year highlighted a number of areas where inclusive design and planning could improve women's experience of using

“Ten years ago, less than one in 10 ICE members were women. Today it is around one in six

infrastructure. And many of these areas of improvement have been suggested by women designers and engineers through their own experiences.

So I'm very happy that the ICE has once again this year supported International Women in Engineering Day (INWED). It recognises women's contribution to engineering, aims to encourage more women and girls to consider it as a career, and celebrates the Top 50 Women in Engineering. I'm delighted that seven ICE members – current or former apprentices Jasmine Ewers, Bethany Holroyd, Kelly Jeffery, Charlotte Jones, Paula McMahon, Tammy Whelan and Daniela Zanni – have made it onto this year's list.

It makes me immensely proud to count these engineers, and those that ICE has been profiling, as members of the Institution. Their passion to build a better, fairer, more sustainable world is truly inspiring. Ten years ago, less than one in 10 ICE members were women. Today it is around one in six, so awareness days such as INWED are having a positive impact on the number of women coming into the industry.

But there is much more to be done to address the gender and diversity imbalance. I would encourage you to tell as many people as you can about the creative and rewarding range of careers on offer in civil engineering to help provide infrastructure for the benefit of all society.

● Kyle Clough is ICE vice president, membership and diversity

WEST MIDLANDS VIEW

UNLOCKING OPPORTUNITY



Malcolm Corlett

The West Midlands is at the centre of the multi-billion pound High Speed 2 (HS2) rail investment and is expected to reap huge benefits from the project. The arrival of HS2 in the region is much more than just that of a strategic

rail network. It is a catalyst for growth that will boost the West Midlands economy by £14bn, creating over 100,000 jobs and regenerating the surrounding towns and cities.

Big infrastructure investment schemes will attract public scrutiny and criticism, and HS2 is no different. But there is no denying that HS2 will totally transform the region by bringing investment, regeneration and a new wave of people looking to relocate to Birmingham and the West Midlands.

The delivery of the Birmingham Curzon Street HS2 station and the High Speed 2 Interchange in Solihull will increase capacity and offer unrivalled connectivity, bringing people and goods to and from London and Manchester in less than 50 minutes. Transport and connectivity are the key drivers for economic growth in the West Midlands and attracting investment into local transport networks is vital for the continuing success of the region. Not only will HS2 increase rail capacity and relieve congestion on rail and road, it will enable more people to travel into the West Midlands for work and will create demand for commercial and residential properties.

The West Midlands is already home to the largest concentration of businesses outside London and the country's largest automotive sector, including Jaguar Land Rover, Rolls-Royce and Toyota. With firms such as HSBC, Deutsche

“HS2 will totally transform the region by bringing investment, regeneration and a new wave of people

Bank and PwC now setting up headquarters in Birmingham, the West Midlands has proved capable of attracting big companies. New labour markets, with access to 2M of the region's population by public transport, will connect supply chains with businesses, helping to drive regeneration, housing and business growth.

The new Curzon Street station and its surrounding £900M regeneration will integrate bus, tram and cycle networks in Birmingham and wider into the West Midlands. This scheme is expected to create 600,000m² of commercial development, 4,000 residential properties and 36,000 new jobs.

The new extension of the West Midlands Metro to Solihull will join the HS2 station at Curzon Street to the Solihull Interchange Hub, connecting thousands of people from the mainline rail networks to towns and cities in the West Midlands by inner-city light rail travel. In addition, Birmingham International Airport which, is served by the Solihull Interchange, will become the UK's only HS2 connected airport.

With quick access to major cities up and down the country, the West Midlands is in a prime position to take advantage of the economic benefits HS2 will bring. HS2 will give the UK, and the West Midlands within it, a vital asset that will serve the nation for many, many years to come.

● *Malcolm Corlett is ICE West Midlands regional chair*



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Heathrow: 18 Jul; Birmingham: 17 Oct

Flood Risk Assessments

Glasgow: 28 Aug; Birmingham: 2 Oct; Manchester: 20 Nov

Drainage Design (Foul & Surface Water)

Heathrow: 16 Oct; Birmingham: 27 Nov

Geotechnical & Piling

Ground Investigation 1:

Ground Investigation Report

Glasgow: 16 Oct; Cardiff: 24 Oct; Manchester: 3 Dec

Ground Investigation 2:

Interpretation for Design

Glasgow: 17 Oct; Cardiff: 25 Oct; Belfast: 7 Nov; Manchester: 4 Dec

Sheet Piling & Cofferdams - Construction

Belfast: 17 Oct

Health, Safety & Welfare

Legislation

(ICE Attribute No 6 & IStructE Core Objective 3.2 & 3.3)

Birmingham: 7 Nov

Regulations & Codes

(ICE Attribute No 6 & IStructE Core Objective 3.2 & 3.3)

Glasgow: 18 Jul; Birmingham: 14 Aug

Site & General Safety

(ICE Attribute No 6 & IStructE Core Objective 3.2 & 3.3)

Birmingham: 23 Jul; Glasgow: 17 Sep

CDM Regs and Compliance 2015

Bristol: 22 Aug; Glasgow: 28 Nov; Heathrow: 11 Dec

CDM Regs 2015 Overview for Designers

Birmingham: 11 Sep; Manchester: 3 Oct; Heathrow: 22 Oct

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Salary: Competitive

Location: London

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Link: <http://bit.ly/SrnStrucEng>



Job title: Principal Project Manager

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Link: <http://bit.ly/RenProjManager>



Job title: Drainage/Civil Engineer

Salary: £30,000 - £40,000

Location: York

The position is an amazing opportunity for an engineer to join the team to assist in the delivery of the growing workload we have secured. Working within our practice will see you apply your civil engineering knowledge on projects that transfer across many sectors of the construction industry.

Link: <http://bit.ly/RVintEng>



Job title: Senior Civil Engineer (Surface Water)

Salary: Excellent package

Location: Cardiff, UK

SRK is an international consulting practice providing integrated services to the global mining industry. We have an exciting opportunity within our Water team for an experienced civil engineer/hydrologist. The role is technically varied and challenging, and you will contribute to projects at all levels of mine project development from initial scoping studies through to construction, operations and closure.

Link: <http://bit.ly/SRKConsulting>



Job title: Planning Manager - Airport

Salary: Up to AED 50k per month

Location: Kuwait

Our client is a leading international consultancy, they have a requirement for an experienced Planning Director to join their team and work on a large Airport project in Kuwait. Candidates applying for this role will have a bachelor's degree in Civil engineering or Quantity Surveying, a minimum 15 years post graduate experience and experience working on large infrastructure and aviation projects.

Link: <http://bit.ly/PlanningManager>



Job title: Registration of Interest

Salary: Dependant on role

Location: Australia

Rail Projects Victoria is seeking registrations of interest to develop an understanding of organisations with the requisite experience and capability to assist in the delivery of Suburban Rail Loop. Suburban Rail Loop is a proposed new orbital rail link connecting Melbourne's middle suburbs to priority growth precincts. It will also include new stations and precinct development.

Link: <http://bit.ly/RailVictoria>

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