

Profitable Markets

Healthy Communities

Environmental Limits

Sustainability  
...a collective responsibility

# Can sustainability win you more work?

10th April 2013

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Technical Director  
Balfour Beatty Ground Engineering



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- Balfour Beatty Sustainability Agenda
- BBGE examples
- Case studies – can sustainability win you more work?

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## Introduction

- I have to consider sustainability for BBGE and our own suppliers, plus Balfour Beatty Group requirements, and in addition for all the external contractors, consultants, management contractors and clients that we work for
- Past chairman of DFI's Sustainability Committee
- Helping to develop a new Europe wide EFFC-DFI carbon calculator for deep foundation products

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What does sustainability mean to you personally and professionally?

Can you really be concerned about >100 years from today?

Different parties to a contract will have conflicting views!

Technical v Economic interests – can we really co-operate regarding sustainability?

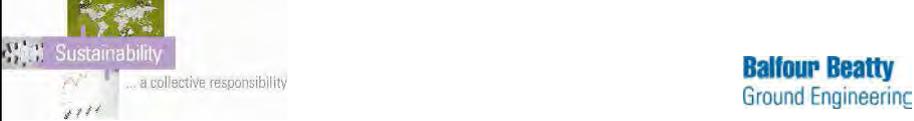
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A building or structure above ground;

- Uses man made materials
- Material behaviour can be tested beforehand away from the worksite
- New construction processes can be trialled beforehand away from the worksite
- So new materials or processes can be proven without delaying the project
- And new materials or processes can likely be used on any project anywhere

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The foundations;

- Combine man made and natural materials
- Unique combination of loadings and ground conditions on every project
- Actual behaviour cannot be tested beforehand away from the worksite
- New construction processes cannot be trialled beforehand away from the worksite

So how do we achieve sustainable foundations without delaying the project?

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Barriers to sustainable foundations;

- Sustainability assessment tools are for master planning only
- No industry consistent method to compare energy consumption of different foundations
- Planning doesn't directly require a green foundation
- Rarely time for site specific trials
- Procurement does not appoint foundation designer early enough
- Lack of training in sustainability and communication on all sides

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How do we get around all this?

- Need the sustainable solution to be the cheapest solution
- Should appoint foundation designer early
- Need smarter contract conditions as likely to be more risk for all concerned
- Need inspectors / certifiers / checkers to help and not hinder

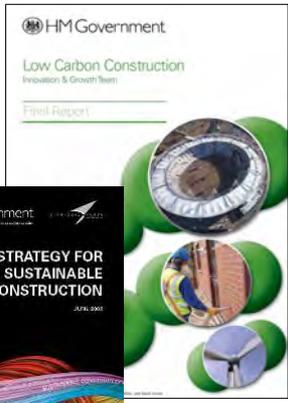


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## Why?

- UK Government;
  - Strategy for Sustainable Construction (2008)
  - Low Carbon Construction report (2010)
  - Green Construction Board (2011)
  - Low Carbon Construction Action Plan (2012)




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## Why?

- Work winning
  - Client sustainability requirements
  - Previous experience required
  - External bid support




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**Why?**

- Customer expectations
  - Increasing requirements
  - Competition from others
- Customer feedback
  - M4-M5 - 8/10
  - A3 - 9/10
  - A421 - 9/10
  - A46 - 10/10
  - Blackfriars - 9/10

**Thameslink Programme**  
**Sustainable Design & Construction Strategy (SDCS)**

Requested by: [Signature] Date: 05/11/10

Approved by: [Signature] Date: 17/11/10

Authorised by: [Signature] Date: [ ]

Issue record

| Issue | Date     | Description                    |
|-------|----------|--------------------------------|
| 1.0   | 10/09/10 | Final version                  |
| 2.0   | 10/09/10 | Final version for construction |

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**Crossrail Sustainability Strategy**



The aim of paper is to explain the Crossrail sustainability strategy and the high level approach to managing the portfolio of sustainability related activity.

| Date     | From     |
|----------|----------|
| 01/11/10 | 01/11/10 |
| 02/11/10 | 02/11/10 |
| 03/11/10 | 03/11/10 |
| 04/11/10 | 04/11/10 |
| 05/11/10 | 05/11/10 |

For Internal Distribution Only

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**Balfour Beatty Sustainability Vision**

**2020 vision**

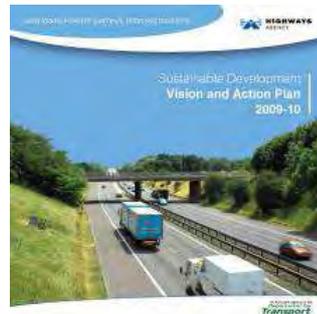
- Profitable Markets**
  - Customers
  - Influence
- Healthy Communities**
  - Our people
  - Our supply chain
  - The communities we serve
- Environmental Limits**
  - Climate change
  - Waste
  - Water
  - Materials
  - Ecology
- Commitment**
- Innovation**
- Integrity**
- Durability**
- Sustainable Successful Balfour Beatty**

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## Profitable Markets

- **Clients**
  - Making sure we meet the clients expectations for sustainability
  - Making sure we lead the field in our products and services
- **Influencing**
  - Driving best practise in the industry for sustainability



## Healthy Communities

- **Our People**
  - Making sure we have well trained and motivated staff
  - Ensuring health and safety
- **Our Supply Chain**
  - Working with our supply chain and helping them to manage their sustainability impacts
- **The Communities we serve**
  - Developing excellent relations with the local community



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## Environmental Limits

- **Climate change**
  - Reducing our emissions of greenhouse gases
  - Providing energy-efficient solutions for our clients
- **Waste**
  - Reducing the waste we produce and making use of 'waste' as a resource
- **Water**
  - Reducing our use of water
- **Materials**
  - Buying sustainable materials
- **Ecology**
  - Protecting and improving local wildlife





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## Sustainability Performance...Heathrow T2B

- On track to achieve BREEAM Very Good, The first BREEAM award for an airport building
- Low carbon design to beat Building Regulations Part L by >22%
- 98% recycling rate for construction wastes
- 100% of timber from sustainable sources
- Eliminating use of harmful substances, e.g high VOC paints
- Over 600,000m<sup>3</sup> of excavated material to be beneficially reused, zero to landfill



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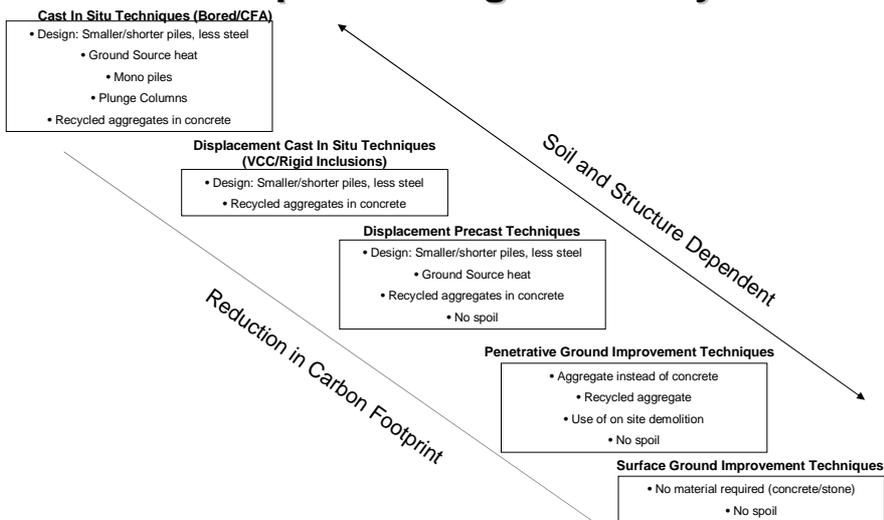
## Sustainability Performance...BBGE

- The most sustainable solution offered to every client
- The carbon of different solutions is compared as well as the technical benefits
- Ground source heat pumps provide renewable energy at our Scottish office
- Precast piles are all made with certified 'responsibly sourced' materials
- 18% less CO<sub>2</sub>e per m<sup>3</sup> of concrete, through using 25% PFA cement replacement for precast piles

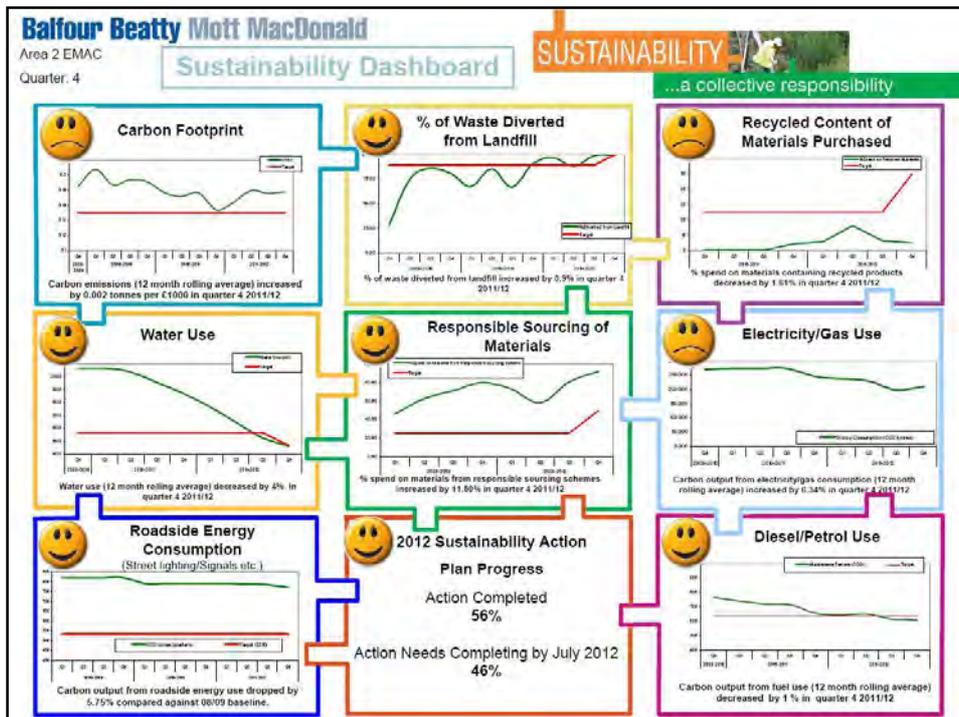


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## Sustainable Optioneering Hierarchy



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**BBGE examples**

The slide features a world map with several locations marked by small icons. Below the map, there is a graphic of interlocking puzzle pieces. At the bottom, a line graph shows a fluctuating trend over time, with labels for "May", "July", "Sept", and "Nov".

## Efficient Design

- Early contractor involvement
- Are foundations over-designed?
- Optioneering
- Value engineering
- Observational approach
- Need an experienced design team
- Finite element modelling
- Have to think about things differently (including risk!)



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## Geothermal Piling

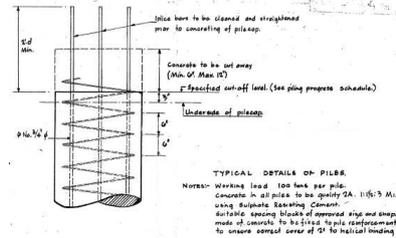
- Precast, Bored piles, CFA, Diaphragm Walls



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# Re-use of piles

- Reliability of original construction
- Information reliability
- Geotechnical capacity
- Damage
- Durability
- Acceptability / level of risk



| Type of Foundation  | Consumption of Materials | Installation Energy |
|---|--------------------------|---------------------|
| New foundations positioned not to clash with existing foundations                                   | High                     | High                |
| New foundations clash with existing foundations so that they need to be removed                     | Very High                | Very High           |
| Re-use existing foundations but not adequate on their own so supplemented with some new foundations | Medium                   | Medium              |
| Re-use existing foundations so that they are adequate on their own                                  | Low                      | Low                 |

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# Steel piles



Courtesy Dawson

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**Recycled aggregates in stone columns** 26

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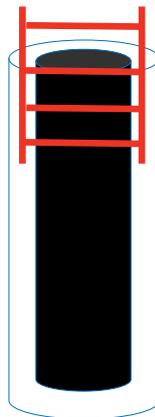


Case Studies – can sustainability win you more work?

| Month | Profit |
|-------|--------|
| May   | Low    |
| July  | Medium |
| Sept  | High   |
| Nov   | High   |

## Hollow Piles

- Collaboration with City University
- As strong as conventional piles
- Up to 44% less concrete
- Void could potentially be used for spoil disposal



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The diagram illustrates a process of consolidation. On the left, four separate, vertical blue tubes of varying heights are shown. An orange arrow points from these tubes to a single, larger blue tube on the right. Inside this larger tube, there is a solid black vertical core. A red ladder-like structure with three horizontal rungs is positioned at the top of the black core, extending slightly beyond the inner walls of the blue tube.

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The diagram shows the final stage of the process. A single large blue tube is shown, containing a solid black vertical core. The top of the black core is capped with a solid orange disc. The orange cap is slightly wider than the black core, fitting snugly within the blue tube's opening.

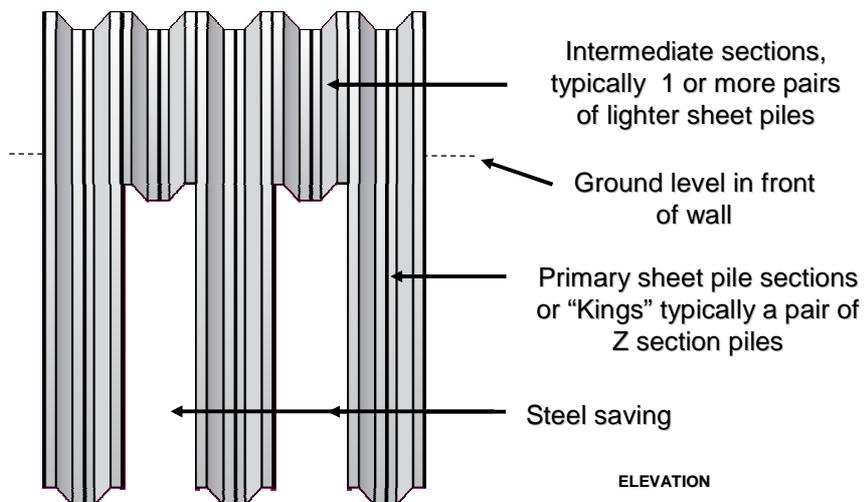
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## M25 Widening Project

- M25 widening scheme commenced in May 2009
- The scope; 60km of widening with Controlled Motorway Technology
- Contract Value is £1,014m
- On programme, and under budget
- Is delivering considerable cost savings to the Highways Agency
- Section 1 (Jct 16-23) has a high volume of Sheet Piling installed due to the speed of installation on an extremely challenging programme

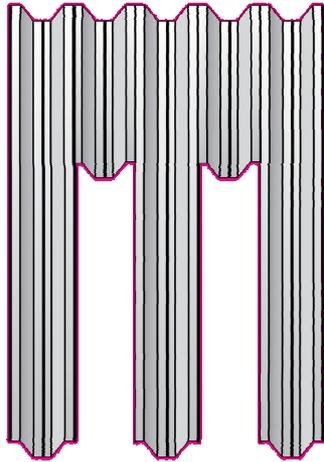
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## King Sheet Pile System (KSP)



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## King Sheet Pile System (KSP)



- “King piles” – same as in standard wall
- Intermediates span horizontally - typically crimped pairs of lighter, sheet piles, e.g. AZ 12 – 770s
- Alternatively, intermediates can be r/c, GRP, timber, plastic, planks or panels, etc and may be arched to operate either in tension or compression
- Cantilever or anchored retaining wall applications

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## KSP – How Does It Work?

- Driveability often dictates use of heavier sections
- Many walls have more structural capacity than required by the design
- KSP “thinks laterally”, exploiting this with full-length “Kings” with other members, typically shorter and lighter Z sections, spanning horizontally between them

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## KSP – Sustainability Benefits

- Typical reduction in steel used is circa 30%
- Sheet piles can be re-used or re-cycled
- Reduced volume of excavation compared to reinforced concrete or bored pile walls.
- Reduced haulage from lower volumes of material import and waste export.

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## KSP – Other Environmental Benefits

- Reduced driving energy due to low clutch friction
- Noise of driving substantially reduced
- Vibration substantially reduced
- Reduced disruption due to faster installation
- Less steel shipped & less lorry traffic
- General reduction in embedded carbon

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## KSP – Safety & Productivity Benefits

- Safety enhanced – reduced working at height
- Short, wider intermediates reduce driving time
- Clutch friction largely eliminated, speeding drive
- Back-driving, where required, at least halved
- Can be installed by simple pitch & drive
- Easy to maintain wall alignment
- Typically twice as fast as normal sheet pile wall

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## M25 – Placing a King



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## M25 – Placing an Intermediate



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## M25 – Finished wall with steel capping beam



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## A421 – Marston Pumping Station

**Facilitated £700,000 saving + programme benefits**



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## KSP - Conclusion

- KSP a major success story on M25 & A421
- Steel saving typically 30% or more
- Substantial productivity improvements
- Substantial environmental benefits
- Available under licence (patent pending)

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## APPLICATION OF TYRE BALES – A421



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## So what are tyre bales?

- Lightweight
- Permeable (0.02m/s length and 0.2m/s through depth)
- Porous (62%)
- High bale to bale friction
- Low thermal conductivity thermal insulation
- Further properties
- Low energy manufacture
- Cheaper option



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## Turning a problem into a solution

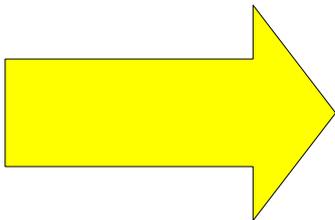
An environmental problem !



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Into an Engineering Solution

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### A brief history of the site

- Original area excavated in the early part of the 20<sup>th</sup> century as a clay borrow pit – backfilled with soft clay slurry and construction waste in the 1960's.



### **The Problem**

- Traditional piling techniques too expensive.
- Traditional fill options with lightweight material could have been used, but very expensive. i.e. MAXIT

## The Solution

- To find a cost effective, environmental friendly and light weight material.
- To have the material sourced locally to the project.
- BB brought this idea to the Project, the idea is to use TYRE BALES. Which is £25/m<sup>3</sup> cheaper then Maxit light weight aggregate.

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## East side tyre embankment



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**Healthy Communities**

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**I believe that sustainability  
is part of good engineering  
and so will help win you  
work!**

**Thank you 😊**