Crib Wall, Ash Vale, Aldershot

[15]

A partially collapsed and dilapidated 20m section of brick retaining wall along the boundary with the A321 (Vale Road) was replaced during highway and bridge upgrades and improvements. The use of a Concrete Crib Wall in the design solution resulted in a CO_2 reduction of 70%.

Ash Vale Crib Wall Case Study: Key Facts

- The use of a crib wall over a traditional "L" shaped reinforced concrete retaining wall saved 220 tonnes of waste material which would otherwise have been sent to landfill for disposal.
- Keeping the material on site avoided the need to import 220 tonnes of granular fill.
- Overall, the reduction in waste and import by selection of the Geosystems approach over the reinforced concrete wall meant a CO_2 saving of 70% and a cost saving of around 18%, not including the avoided costs of diverting or re-instating services.

Project Details

A dilapidated 20m brick retaining wall was present along the bottom of the garden at No. 1 Vale Road, adjacent to the A321 Vale Road embankment. Surrey County Council replaced this wall as part of a scheduled programme of upgrades and improvements to the A321. The work was commissioned by Surrey County Council, and Osbourne Ltd was the main Contractor with Phi Keller providing specialist design and construction of the Crib Wall.

By using a Geosystems solution, savings were realised during the construction phase through the reduction of both waste material and the amount of imported fill. The original proposal (see Figure 1) involved the excavation of the road embankment to create a wide enough base for the reinforced concrete retaining wall, which was to be clad in brick on the side facing the residential property.

However, the traditional solution was logistically problematical due to the presence of several utilities within the embankment. The crib wall alternative solution (see Figure 2) was proposed, and ultimately implemented, since this required a reduced amount of embankment excavation and left the utilities undisturbed. Additionally the Geosystem solution resulted in less encroachment into the garden of the residential property.

Significantly, by reducing the volume of embankment excavation, the Geosystem solution reduced the amount of waste material generated and correspondingly the need to import granular fill. This produced the reduction in associated cost and CO_2.

Comparison of the two designs

Environmental and financial costs

Figure 3 illustrates the different approaches required to deliver the two alternative designs, and assigns the calculated values for embodied CO_2 to each stage. Figure 4 does the same thing for the financial costs. The calculations from which the two sets of figures are derived follow.

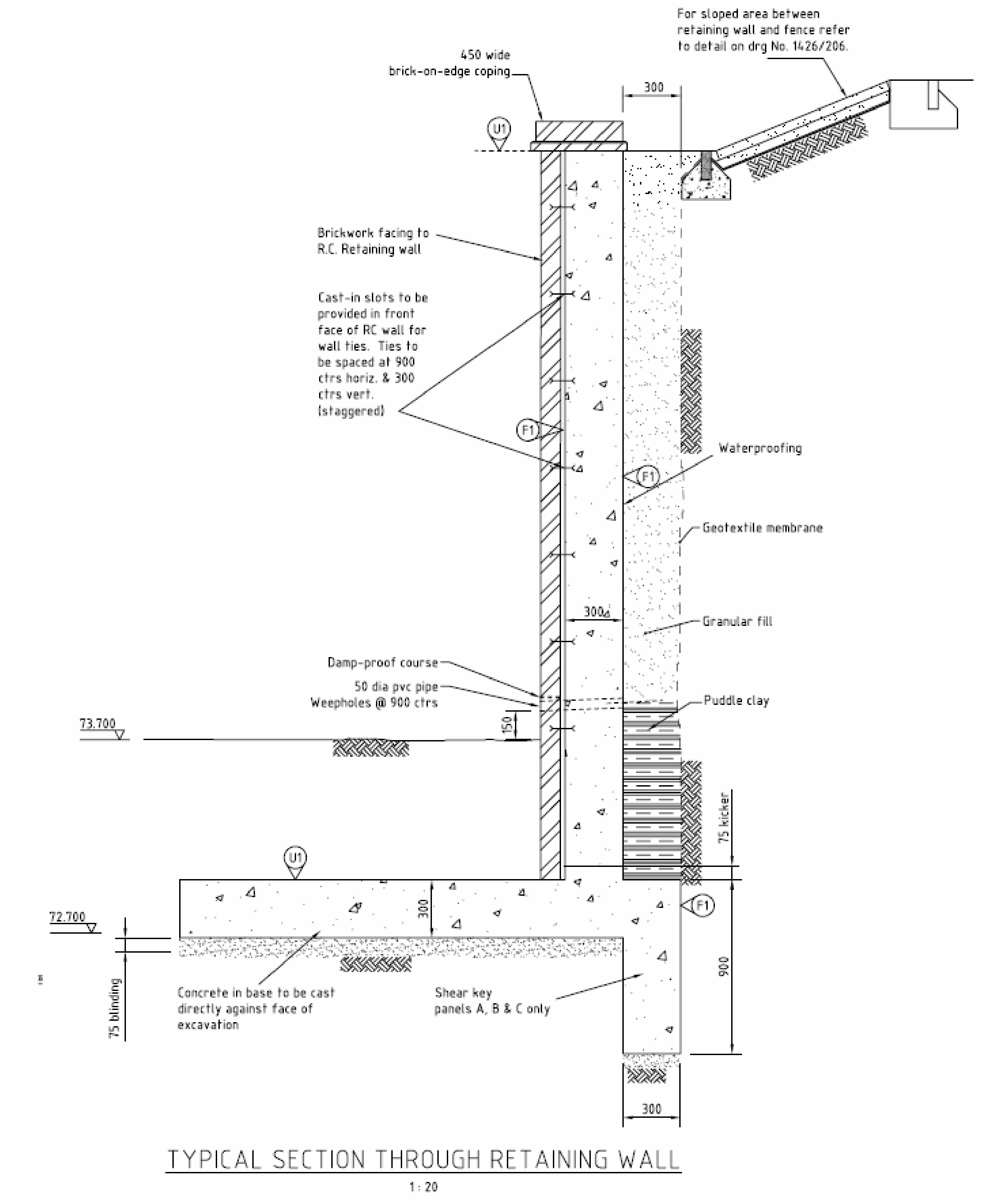

Figure 1: *Detail of the originally proposed reinforced concrete wall with brick cladding design*

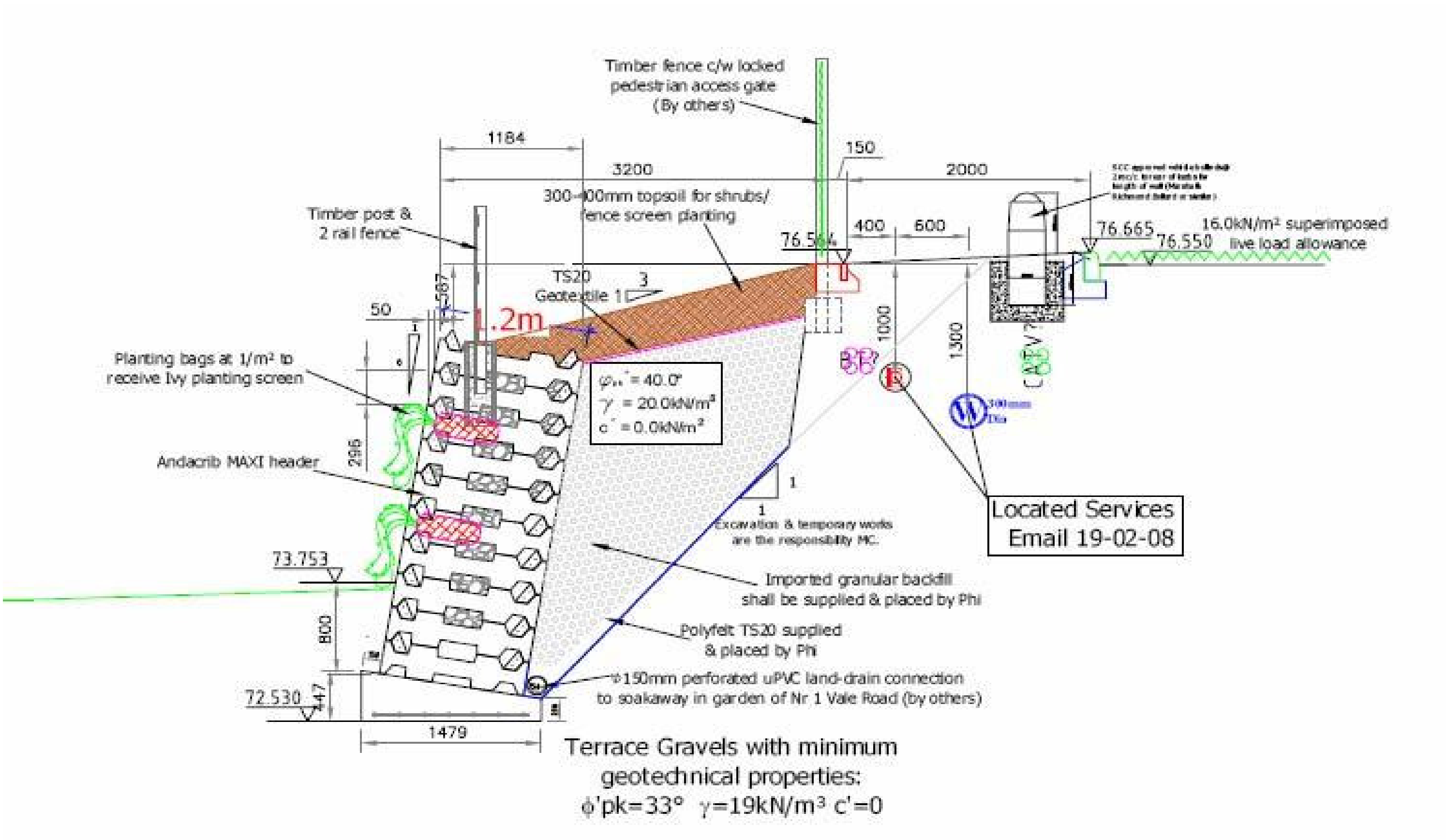

Figure 2: *Detail of the Concrete Crib Wall design constructed at As Vale, Aldershot*

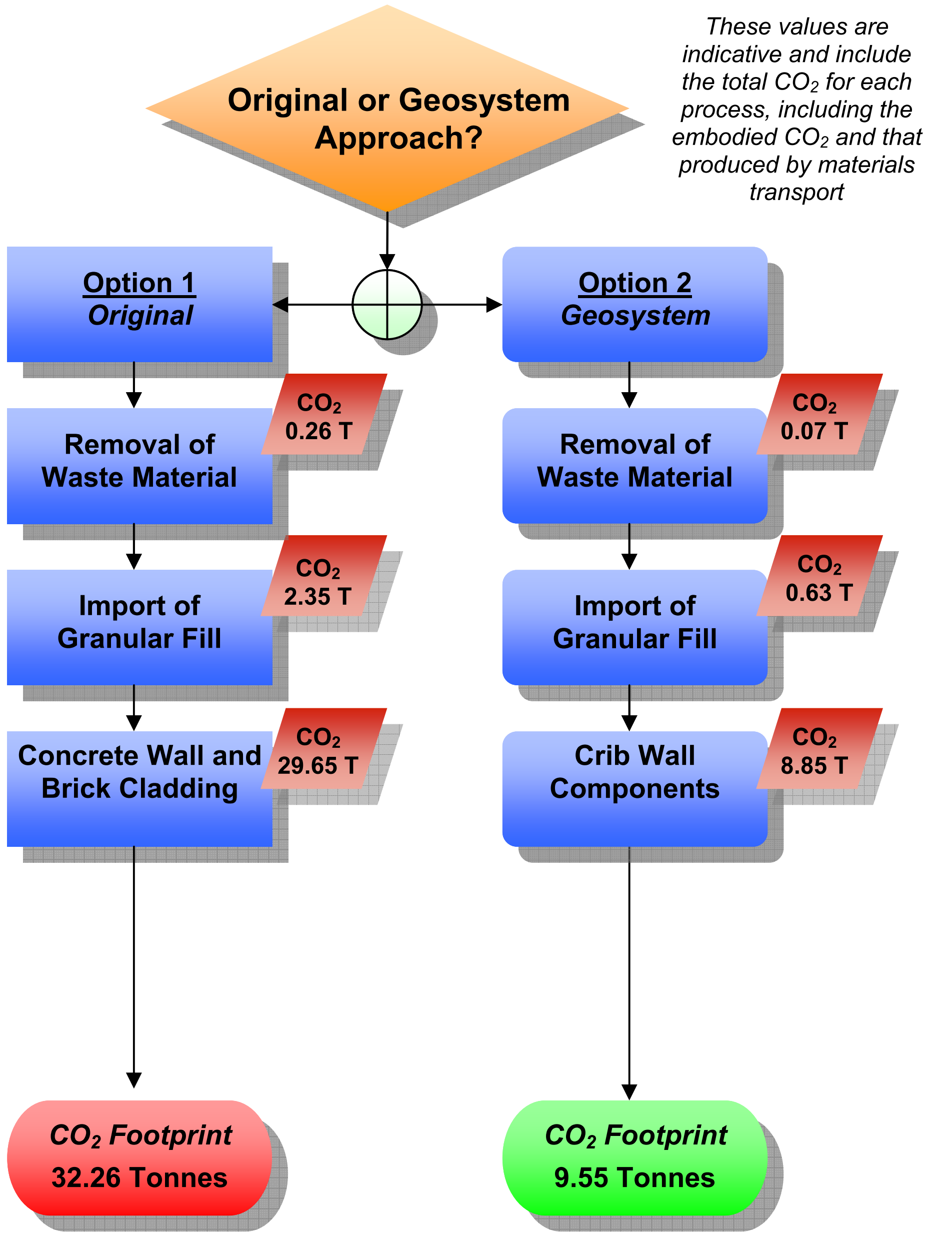

Figure 3: *Flowchart comparing the alternative options for construction of the retaining wall and their associated carbon footprints*

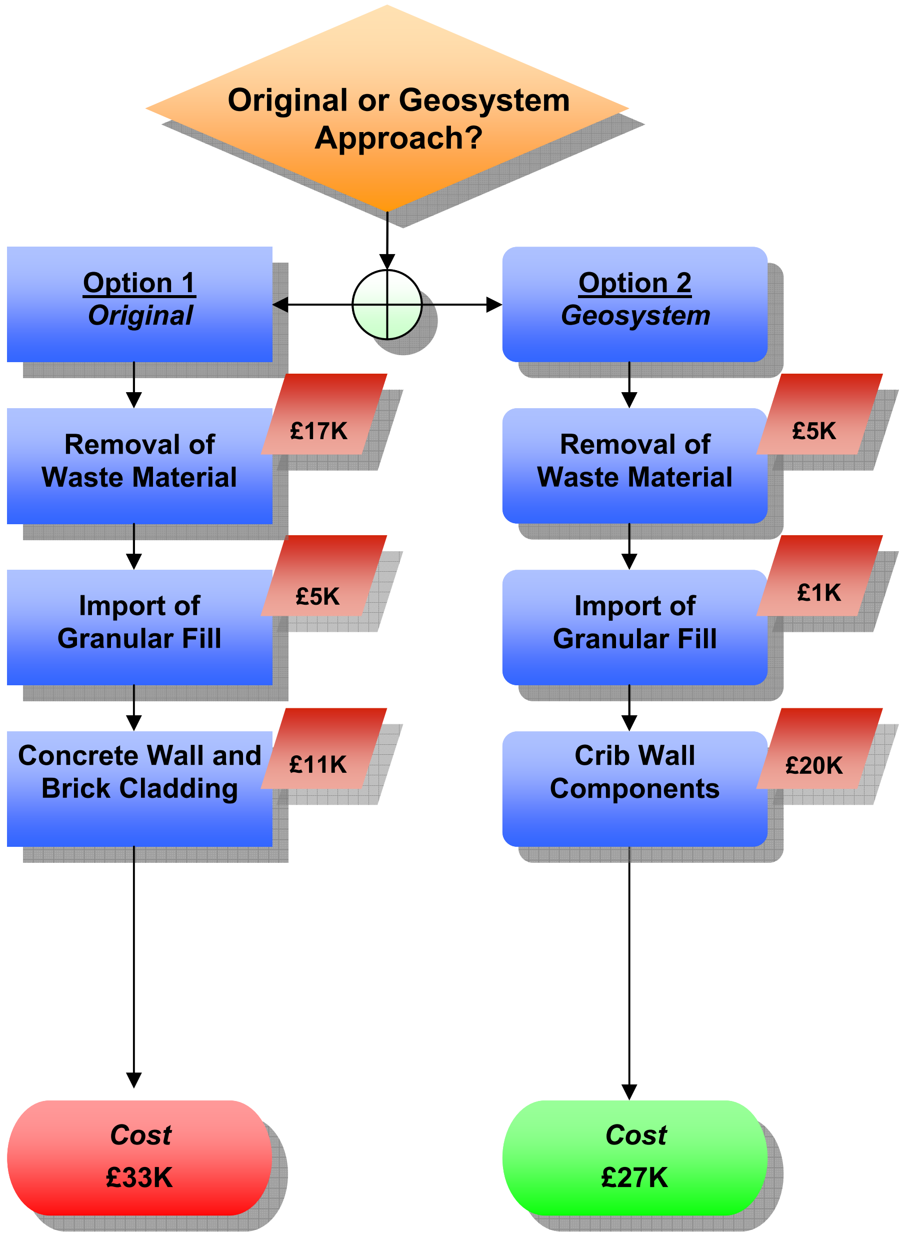

Figure 4: *Flowchart comparing the alternative options for construction of the retaining wall and their associated financial costs*

Supporting calculations

Disposal of waste materials

The original proposal would have involved the removal of some 300 tonnes of excess material from the ground works to enable construction of a reinforced concrete retaining wall. This waste material would have been transported by road and disposed of at Runfold North Landfill, 5.75 miles away.

However, the reduced width of the Geosystems solution compared to the reinforced concrete wall solution resulted in only 80 tonnes of waste material being generated from the excavation works. This reduction in excavation quantities resulted in a cost saving of approximately £12,678 from reduced haulage, landfill tax and gate fees for the disposal of the waste material.

This reduction in the volume of waste in turn significantly reduced the carbon footprint of the project. Transporting 300 tonnes of waste material to the disposal site, as proposed in the original scheme, would have resulted in 0.26 tonnes of CO_2. By contrast, the removal of only 80 tonnes of excess material in the Geosystems approach produced only 0.07 tonnes of CO_2, a saving on this element of the project of 73%.

Table 1: *Comparison of Exported* ***Waste Materials***

Method	Material (Tonnes)	Total CO_2 [1] (Tonnes)	Total Cost [2] (£)
Reinforced Concrete Wall	300	0.26	17,290
Concrete Crib Wall	80	0.07	4,610
Total Saving	**220**	**0.19**	**12,680**

Import of Fill Materials

In the original proposal (based on a reinforced concrete retaining wall), 300 tonnes of granular fill would have been required to fill the void behind the concrete retaining wall upstand. This material would have been imported from Mortimer, Berkshire by road, a distance of 19 miles, at a calculated cost of approximately £4,950.

The Geosystems solution meant that less material needed to be removed, and a correspondingly reduced quantity of imported granular fill was needed to construct the crib wall. The reduction of 80 tonnes of imported fill saved around £1,320, and resulted in a significantly reduced carbon footprint.

The 300 tonnes of imported granular fill required by the original solution would have had a total of 1.50 tonnes of embodied CO_2. Additionally, transportation of the imported materials would have generated a further 0.85 tonnes. By contrast, the reduced quantities in the Geosystems solution involved a total of some 0.40 tonnes of embodied CO_2 with an additional 0.23 tonnes of CO_2 generated during delivery.

[1] *Values for CO_2 include embodied energy and that produced by haulage*
[2] *Includes costs for gate fee, tax & haulage*

Table 2: *Comparison of Imported **Fill Materials***

Method	Material (Tonnes)	Total CO_2[3] (Tonnes)	Total Cost[4] (£)
Reinforced Concrete Wall	300	2.35	4,950
Concrete Crib Wall	80	0.67	1,320
Total Saving	**220**	**1.68**	**3,630**

Structural materials

Concrete brick-clad wall

The original design was for a reinforced concrete wall clad with bricks. Around 74 tonnes of concrete would have been necessary to construct the reinforced concrete wall, which would have had an embodied CO_2 content of approximately 17.93 tonnes with an additional 0.05 tonnes of CO_2 released during delivery to site. The concrete would also need to be reinforced with (energy-intensive) steel, which would have contributed an additional 4.95 tonnes of embodied CO_2. Approximately $60m^2$ of brick cladding would have been needed to complete the structure, with an embodied CO_2 content of 6.70 tonnes, with a further 0.02 tonnes of CO_2 being released during transportation of the bricks. The reinforced concrete and brick cladding materials would have cost approximately £10,630.

[3] *Values for CO_2 include embodied energy and that produced by haulage*
[4] *Costings include haulage and were provided by the contractor*

Geosystem

The crib wall was constructed using Andacrib reinforced concrete geo-components. The Andacrib components were delivered[5] to site by road resulting in an overall delivered cost of £20,048.00.

A total of 121 concrete headers and 212 stretchers were delivered, with an embodied CO_2 content of 4.29 tonnes. These were reinforced with steel, adding 0.09 tonnes of embodied CO_2. An estimated 0.76 tonnes of CO_2 was generated through the transportation of the Andacrib components to site.

Slightly less than 30 tonnes of concrete was required for the footer, with an associated embodied CO_2 content of 3.69 tonnes (and an additional 0.02 tonnes of CO_2 arising from its delivery).

Table 3: *CO_2 and Costing for **Structural Materials***

Method	Total $C0_2$[6] (Tonnes)	Total Cost[7] (£)
Reinforced Concrete Wall	29.77	10,630
Concrete Crib Wall	8.87	20,048
Total Saving	**24.20**	**-9,418**

Summary

Figures 3 and 4 (above) provide summaries of the total embodied CO_2 (carbon footprint) including transport, and the financial cost for both solutions (the traditional reinforced concrete wall design and the Geosystem-based crib wall).

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[5] *Assumed that all Andacrib were imported from Nuneaton, Warwickshire*
[6] *Values for CO_2 include embodied energy and that produced by haulage*

Basis for carbon and cost calculations

Table 4 provides the basis for the embodied CO_2 calculations used in this Case Study. This excludes any consideration of CO_2 emissions from transport to site.

Table 4: *Calculations used to determine the embodied CO_2 of materials*

Supplier	***Product***	***Mass (tonnes)***	***Embodied Carbon Value*** (Ref 3) ***in tonnes of CO_2 per tonne of material***		***Embodied Carbon (tonnes)***
Granular Fill	Aggregate	300	Aggregate	0.005	1.50
Concrete	Concrete	74.4	Concrete (RC40)	0.24	17.86
Rebar	Steel	1.85	Steel (Virgin Rod)	2.68	4.95
Brick Cladding	Facing Bricks Concrete	12.89	Concrete (Facing Bricks)	0.52	6.70
Maxi Header	Concrete	6.68	Concrete (RC35)	0.23	1.54
Rebar	Steel	0.013	Steel (Virgin Rod)	2.68	0.03
Stretcher	Concrete	11.7	Concrete (RC35)	0.23	2.69
Rebar	Steel	0.023	Steel (Virgin Rod)	2.68	0.06
Footing	Concrete	28.8	Concrete (RC20)	0.13	3.74
Granular Fill	Aggregate	80	Aggregate	0.005	0.40

Table 5 provides the cost factors used in this Case Study.

Table 5: *Material Costs for both methods and the Sources for Costs*

Material	***Unit price***	***Source of price***
Waste material (gate fee + tax)	£45 / tonne	WRAP (Comparing the cost of alternative waste treatment options)
Waste material (transport)	£225 / tonne plus £55 / driver-hour	Haulage company
General fill material	£16.50 / tonne	Supplier / manufacturer
Reinforced concrete wall	£297.17 / m length	Supplier / manufacturer
Brick cladding	£79.89 / m²	Supplier / manufacturer
Maxi-header and stretcher	£20,048 (supply, deliver, build)	Supplier / manufacturer
Footer concrete	£42 / 1.44 tonnes	Supplier / manufacturer

Conclusions

The use of a Geosystems solution (in the form of a crib wall in place of the more traditional solution of a reinforced concrete retaining wall) at the boundary of No1 Vale Road and the A321 demonstrates the cost, logistical and environmental benefits which can be realised.

- Through the reduction of excavated waste arising from the project, a reduction in the associated CO_2 footprint of more than 70% was achieved.
- The reduction in waste material also meant a saving of £12,678 from reduced transportation, landfill tax and gate fee costs.
- The reduction in excavated waste reduced the need for imported fill at a cost saving of around 18%.
- Overall the reduction in costs achieved through the adoption of the alternative solution was £6,052.

Carbon Footprint

- The Geosystems solution reduced the associated carbon footprint of this retaining structure by more than 70% through a reduction in the quantity of excavation and the incorporation of a more efficient crib wall geo-component, compared to the originally proposed reinforced concrete wall solution.
- The Geosystem solution saved approximately 23 tonnes of CO_2, equivalent to more than four round trips from London to Paris by plane[Ref 1]. By way of comparison, it would be necessary to plant approximately 36 ash trees[Ref 2] to offset this.

[Ref 1] *Defra (2007) Department for Transport and AEA Energy & Environment. Guidelines to Defra's GHG conversion factors for company reporting*

[Ref 2] *Carbon Neutral (2009) Plant a Tree for Me, Carbon Offset Tree Planting in Lancashire www.carbonneutralfuel.co.uk, Webmaster: Hubmaker*

[Ref 3] *University of Bath & Carbon Trust, Inventory of Carbon & Energy Version 1.6a*