



Britpave

Concrete Step Barrier Studies

Barrier Cost Comparison:
Stage 2

Basic barrier costs

July 2008

Britpave, the British In-situ Concrete Paving Association, was formed in 1991. It is active in all areas of transport infrastructure including roads, airfields, light and heavy rail, guided bus, safety barriers and drainage channels, soil stabilisation and recycling.

The Association has a broad corporate membership base that includes contractors, consulting engineers and designers, suppliers of plant, equipment and materials, academics and clients both in the UK and internationally.

Britpave provides members and clients alike with networking opportunities. The Association aims to develop technical excellence and best practice in key cement and concrete markets through its publications, seminars and website.



Published by

Britpave

Riverside House, 4 Meadows Business Park,
Station Approach, Blackwater, Camberley, Surrey GU17 9AB

Tel +44 (0)1276 33160

Fax +44 (0)1276 33170

www.britpave.org.uk

All advice or information herein is intended for those who will evaluate the significance and limitations of its contents and take responsibility for its use and application. No liability (including that for negligence) for any loss resulting from such advice or information is accepted by either the authors or Britpave. Readers should note that this publication is subject to revision from time to time and should therefore ensure that they are in possession of the latest version.

CONTENTS		Page
	EXECUTIVE SUMMARY	2
1	INTRODUCTION	4
1.1	Scope and purpose	4
1.3	Cost data	4
2	Barrier systems	5
2.1	Britpave wide profile CSB	5
3	METHODOLOGY	6
3.1	The site	6
3.2	Central reserve layouts	6
3.3	Layouts with lighting columns	9
3.4	Exclusions	9
4	COSTS	13
4.1	General data	13
4.2	Summary	14
4.3	Discussion of costs	15
5	CONCLUSION	16
5.1	Future studies	17

EXECUTIVE SUMMARY

Britpave appointed Arup in February 2007 to carry out a comparative costing analysis of concrete step barrier (CSB) and other steel vehicle restraint systems for central reserve application.

This report should not be used as a pricing tool. The peripheral details of the central reserve construction are broadly common across scenarios regardless of whether steel or concrete barrier systems are installed. Some of the features included in the comparative prices such as central reserve construction will be true for both CSB and steel barrier options. Although the detail of the central reserve assumes a basic construction, any adjustment would be true for both options. The model used in generating the comparative costs does, however, take account of variability in costs of materials and construction techniques.

Stage 1 of this study developed basic comparative costs for central reserve barrier systems. This report is for Stage 2 of the study and considers the influence of different central reserve layouts, and central reserves where lighting columns are installed. This report follows, and should be read in conjunction with, the Stage 1 report.

For typical prices per linear metre of concrete step barrier, refer to the Stage 1 report. This stage 2 report investigates the influence on cost of changing the following conditions in the central reserve:

- Surface treatment – paved surface, soft central reserve
- Width of central reserve
- Lighting columns

Six typical central reserve layouts were considered:

- A. Fully hardened central reserve with standard CSB.
- B. Standard CSB with minimum paved surface.
- C. Soft central reserve, with untensioned corrugated beam barrier (Both driven post and socketed post foundations have been considered).
- D. Wide profile CSB with integral cable trough, lighting columns mounted on top, fully hardened central reserve.
- E. Dual standard profile CSB, lighting columns installed between the barriers, fully hardened central reserve.
- F. Two single sided untensioned corrugated beam barriers, lighting columns installed between barriers, soft central reserve: (both driven post and socketed post foundations have been considered).

For the purposes of the costing exercise, the site was assumed to be 5km of rural motorway, balanced carriageway on embankment. Costs per linear metre were calculated for each layout using data obtained from industry. A summary of the range of costs for each layout is given in the table on page 3.

This study does not quantify whole life costs over the lifetime of the barrier system such as those costs associated with repair, maintenance or replacement. Instead it concentrates on the initial construction costs incurred during barrier installation. The costs used in the comparison which are then discussed in this report were sourced from industry suppliers and are therefore supplier costs for installation of the barrier system by a specialist installer.

All concrete step barriers costed in this study are surface mounted barriers conforming to the Britpave specification and are based on March 2007 prices. Steel barriers have been costed with both driven post and socketed post concrete foundations. Socketed post concrete foundations are the preferred installation type by highway network owners. This foundation type provides for easier replacement of the barrier following impact damage or routine maintenance.

Table 1 – Basic costs per linear metre

	Description	Performance	Cost per linear metre of central reserve. Average \pm 10%			
			Driven post foundation	Socketed post foundation	CSB with flexible composite surface	CSB with rigid composite surface
A	Fully hardened central reserve with standard CSB	H2 W2			£120	£94
B	Standard CSB with minimum paved surface and remainder soft central reserve	H2 W2			£114	£98
C	Soft central reserve, untensioned corrugated beam	N2 W3 or W4 ⁽¹⁾	£77	£83		
		H2 W4	£132	£157		
D	Wide profile CSB with integral cable trough, lighting columns mounted on top, fully hardened central reserve	H2 W3			£185	£155
E	Dual standard profile CSB, lighting columns, fully hardened central reserve	H2 W2			£207	£169
F	Untensioned corrugated beam barriers, lighting columns, soft central reserve	N2 W3 or W4 ⁽¹⁾	£96	£109		
		H2 W4	£142	£167		

⁽¹⁾ Cost based on 4m post centres

Summary of cost ranges for central reserve layouts

Whilst the cost difference between CSB and N2 deformable steel barriers is increased if driven posts are adopted it must be noted that the post centres are assumed to be at 4 metres, which is greater than usual, and that driven posts are not the preferred solution for highway network owners. For post spacings of 2.4 metres N2 steel barrier costs should be increased by 7 per cent for driven post foundations and 14 per cent for socketed foundations. For post centres less than 2.4 metres, a further 7 per cent increase should be applied to the costs.

Principal conclusions of the Stage 2 study are as follows:

- Providing H2 containment performance with CSB profiles is more economic than using deformable steel higher containment systems
- Use of CSB profiles brings cost savings in reduced central reserve width, including land costs and surfacing costs

- N2 deformable steel barriers with soft central reserve offer a more economic but inferior performance option, with high maintenance requirements.

- Hardening the central reserve with concrete is more cost effective than using flexible bituminous pavement.

Reduced central reserve width allows installation of CSB in locations where steel barriers could not be provided without a departure from standard.

For layouts with lighting columns the costs for wide concrete step barrier with integral cable trough are conservatively high. The barrier itself provides the foundation for the lighting columns. Cost savings using this system can be realised by:

- No requirement for independent lighting column foundations.
- Reduced requirement for ducts and draw pits.
- Use of non-armoured cable in the trough.
- Shorter lighting columns (mounted on top of barrier).

1 INTRODUCTION

Britpave appointed Arup in February 2007 to carry out a comparative costing analysis of concrete step barrier (CSB) and other steel vehicle restraint systems for central reserve application.

Stage 1 of this study developed basic costs for the barrier systems under consideration. This report is for Stage 2 of the study and considers the influence of different central reserve layouts, and central reserves where lighting columns are installed. For typical prices per linear metre of concrete step barrier, refer to the Stage 1 report.

This Stage 2 report follows, and should be read in conjunction with, the Stage 1 report, which includes descriptions of the different barrier systems costed for Britpave.

The Stage 2 report will be followed by Stage 3 of the study which will address:

- Transitions.
 - Connections to structures.
 - Terminals.
 - Bifurcation.
 - Drainage details.
 - Emergency crossing points.
-

1.1 Scope and purpose

This Stage 2 report investigates the influence on cost of changing the conditions in the central reserve, including:

- Surface treatment – paved surface, soft central reserve
- Width of central reserve
- Lighting columns

There are a number of items which have been excluded in the cost analysis. These are detailed in Section 3.4. They include drainage, terminals and bifurcations.

Costs have been built up from first principles considering the individual components of each of the barrier systems, as determined in the Stage 1 costing exercise. Construction methods and installation rates have been included in the analysis.

This report does not consider whole life costs over the lifetime of the barrier system such as those costs associated with repair, maintenance or replacement. Costs given in this report are those for capital costs incurred during barrier installation. Broader whole life and sustainability issues are discussed qualitatively in the Stage 1 report.

This report should not be used as a pricing tool. The peripheral details of the central reserve construction are broadly common across scenarios regardless of whether steel or concrete barrier systems are installed. Some of the features included in the comparative prices such as central reserve construction will be true for both CSB

and steel barrier options. Although the detail of the central reserve assumes a basic construction, any adjustment would be true for both options. The model used in generating the comparative costs does, however, take account of variability in costs of materials and construction techniques.

1.2 Cost data

Cost data was obtained in March 2007 from the same sources as were used for the Stage 1 basic barrier costs.

The costs used in this report are supplier costs for installation of the barrier system by a specialist installer. No allowance is made for main contractor on costs.

2 BARRIER SYSTEMS

The barriers used in the Stage 2 study are shown in table 2 below:

Table 2 – Barrier systems used in Stage 2 costing study

Barrier system	Containment performance class	Working width class	Notes
Britpave Surface Mounted CSB – standard profile	H2	W2	Meets TD 19/06 requirements
Britpave Surface Mounted CSB – Wide profile with integral cable trough	H2	W2	Meets TD 19/06 requirements
Untensioned two-rail corrugated beam (Single-sided)	H2	W4 or W5	Does not meet TD 19/06 requirement for concrete barrier
Untensioned corrugated beam (Double-sided)	N2	W3 or W4	Does not meet TD 19/06 requirement for H1 containment or concrete barrier
Untensioned single-rail corrugated beam (Single-sided)	N2	W4	Does not meet TD 19/06 requirement for H1 containment or concrete barrier

A brief description of the standard profile CSB and untensioned corrugated beam barriers is given in the Stage 1 report. Britpave wide profile CSB with integral cable trough is described below. All concrete step barriers costed in this study are surface mounted barriers conforming to the Britpave specification. Both driven post foundations and socketed foundations have been assessed for steel barriers. Driven post foundations are more prevalent on the highway network, however socketed foundation systems are preferred by network owners because of ease of repair following vehicular impact or as a result of routine maintenance.

2.1 Britpave wide profile CSB



Figure 2.1: Wide profile CSB with integral cable trough.

Wide profile Surface Mounted CSB is a slip formed concrete barrier 900mm high above road level with an overall base width of 942mm. The double-sided barrier is designed to withstand impact from either side. The barrier is extruded directly onto the prepared road surface, without the need for an independent foundation.

The top of the barrier provides a 600mm wide platform suitable for mounting lighting columns or signs. Wide CSB profiles can be extruded with an integral cable trough (Figure 2.1). A cable duct is laid in the trough, which can then be infilled with concrete.

The barrier itself provides the foundation for the lighting columns. Independent lighting column foundations are not required.

This is a rigid concrete barrier providing H2 containment with a working width class of W3 (\leq metre). For wide CSB profiles, working width is defined by the base width of the barrier itself.

3 METHODOLOGY

Typical cross sections were drawn up for each of the proposed central reserve layouts. The intention is to provide a typical cost range for a number of scenarios that are representative of central reserve conditions encountered on the UK road network: new build, barrier replacement and motorway widening schemes.

The cross sections are necessarily simplified and generalised; each project will have its own particular constraints and central reserve conditions which will influence the cost.

Costs were calculated for the supply of materials, installation of barriers, and construction of the central reserve.

3.1 The site

For the purposes of this Stage 2 cost analysis, the site is assumed to be:

- 5 km of rural motorway.
- Balanced carriageway on embankment.

3.2 Central reserve layouts

Typical cross sections were developed for three central reserve layouts (figures 3.1 to 3.4) described in table 3.2. All layouts assume a minimum set back of 1.2 metres and no departure from standard on working width. For simplicity, central reserve widths are considered in increments of 0.5 metres.

Options for hardening the central reserve with rigid (concrete) or flexible (bituminous) pavement were considered.

Layout A with standard profile CSB (H2 W2) in a 3 metre central reserve represents the scenario on a motorway widening scheme where carriageways are widened into the median, or a new-build scheme minimising land-take. However, cost savings from reduced land-take have not been included in the analysis. In addition to higher containment, the low working width class of CSB also offers performance advantages over deformable barrier systems. This can be translated into cost savings on a project by minimising the central reserve width.

Layout A has a fully hardened central reserve in accordance with the HA preference to reduce maintenance.

For layout B, a bound pavement layer is provided as foundation for the surface mounted CSB (H2 W2) in accordance with the Britpave specification. The set-back zone is fully hardened on the traffic face and this layer extends to 100mm behind the barrier. The remainder of the central reserve is soft finish, either contiguous drainage filter material for central reserves between 4.5 metres and 6 metres wide, or grass for central reserves wider than 6 metres.

Although soft central reserve has been included in the costing analysis, it should be noted that current guidance from the Highways Agency indicates a preference for a fully hardened central reserve to minimise maintenance.

Layout C, soft central reserve with double sided untensioned corrugated beam barrier, represents the typical scenario for the existing UK motorway and trunk road network. The standard central reserve width of 4.5 metres has been used for this layout. The double sided untensioned corrugated beam provides N2 containment performance with working width W4. Alternatively this layout could be provided with higher containment using a pair of two-rail untensioned corrugated beams (H2 W4 or W5) costed in the Stage 1 study. The surface finish in the central reserve is assumed to be contiguous drainage filter material.

Steel barriers have been costed with socketed concrete foundations. This foundation type provides for easier replacement of the barrier following damage. Driven posts provide a cheaper foundation for steel barriers but are dependent on good ground conditions in the central reserve. Costs are also provided for driven post foundations.

Table 3.2 – Typical central reserve layouts

Layout	Description	Performance	Min. central reserve	Figure
A	Fully hardened central reserve with standard CSB	H2 W2 Higher containment	3 metres	3.1
B	Standard CSB with minimum paved surface (extends to 100mm behind barrier) and remainder is soft central reserve	H2 W2 Higher containment	4.5 metres	3.2
C	Soft central reserve, with double sided untensioned corrugated beam barrier	N2 W3 or W4 Normal containment	4.5 metres	3.3 Socketed post 3.4 Driven post

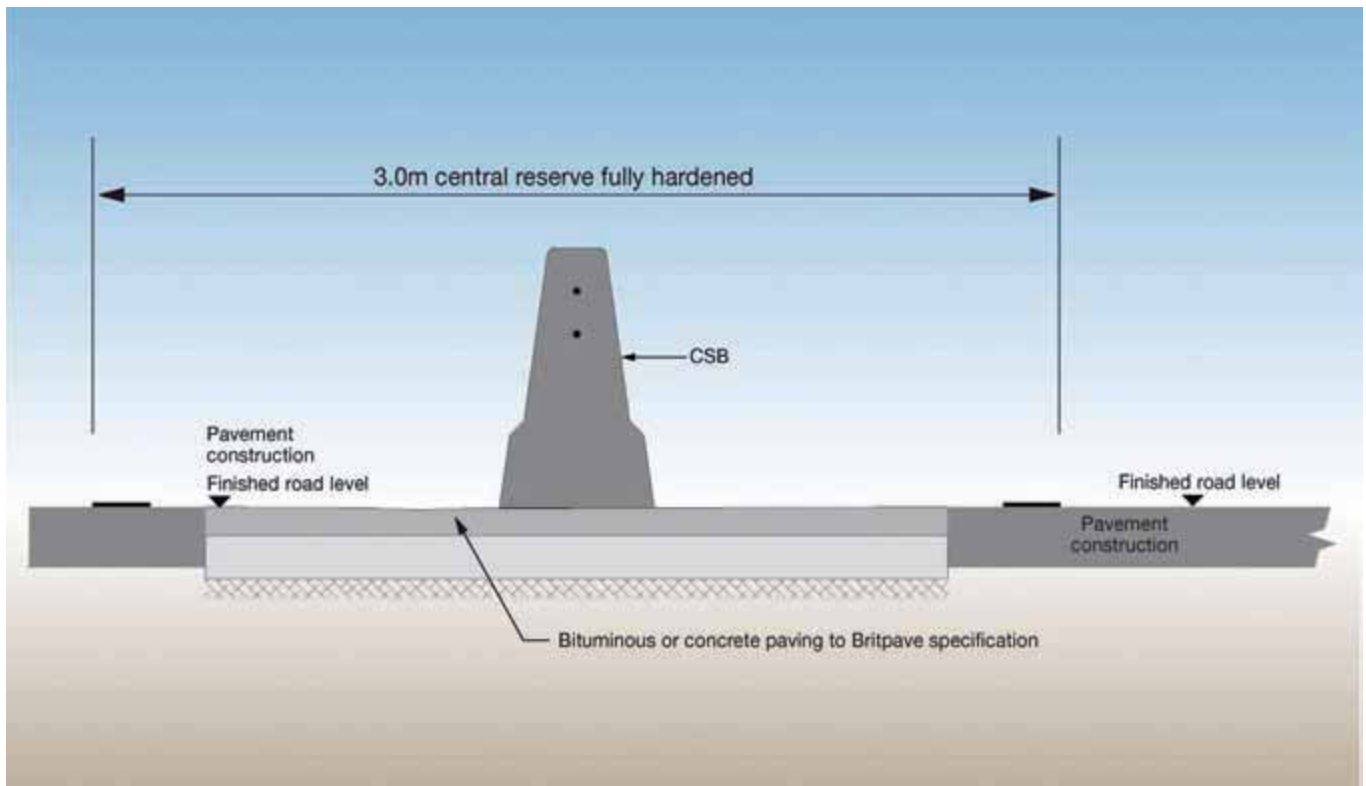


Figure 3.1: Layout A - Fully hardened central reserve with standard CSB.

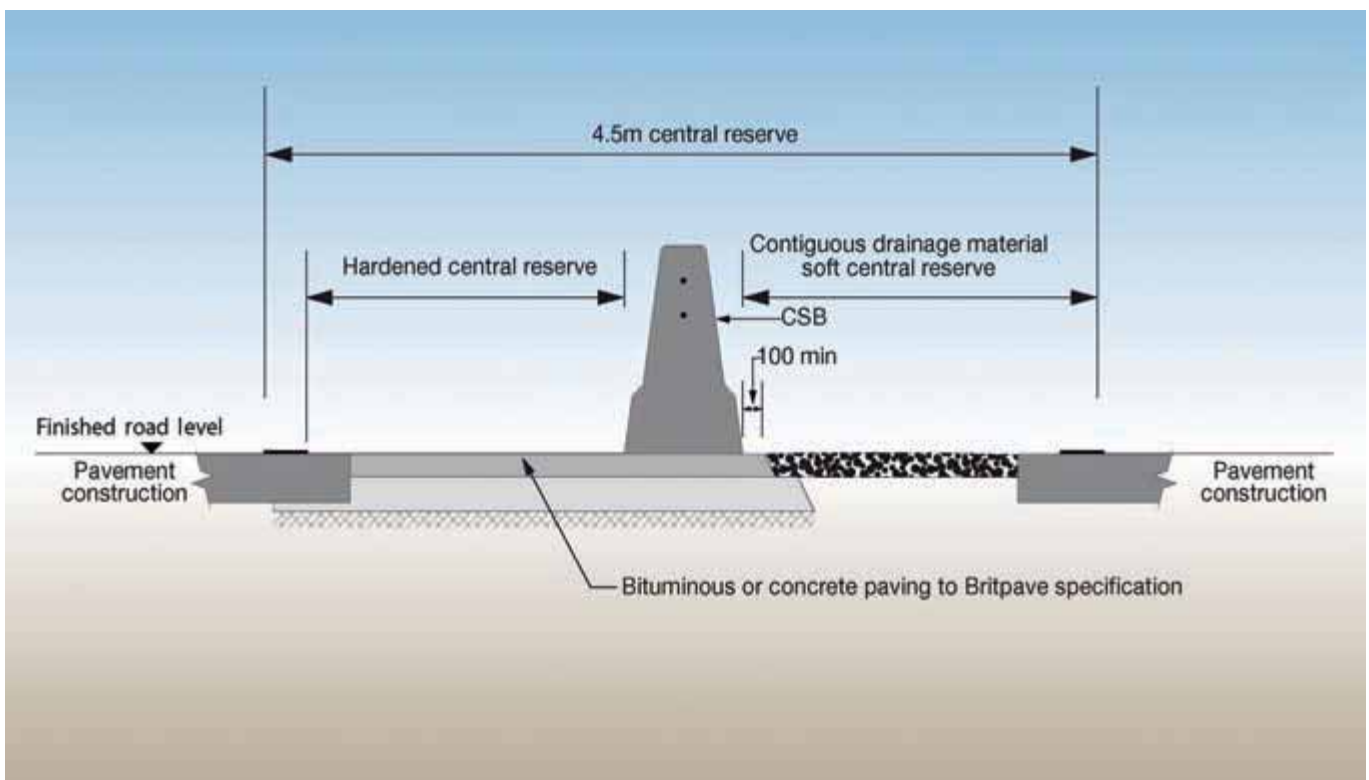


Figure 3.2: Layout B - Standard CSB with minimum paved surface and soft central reserve.

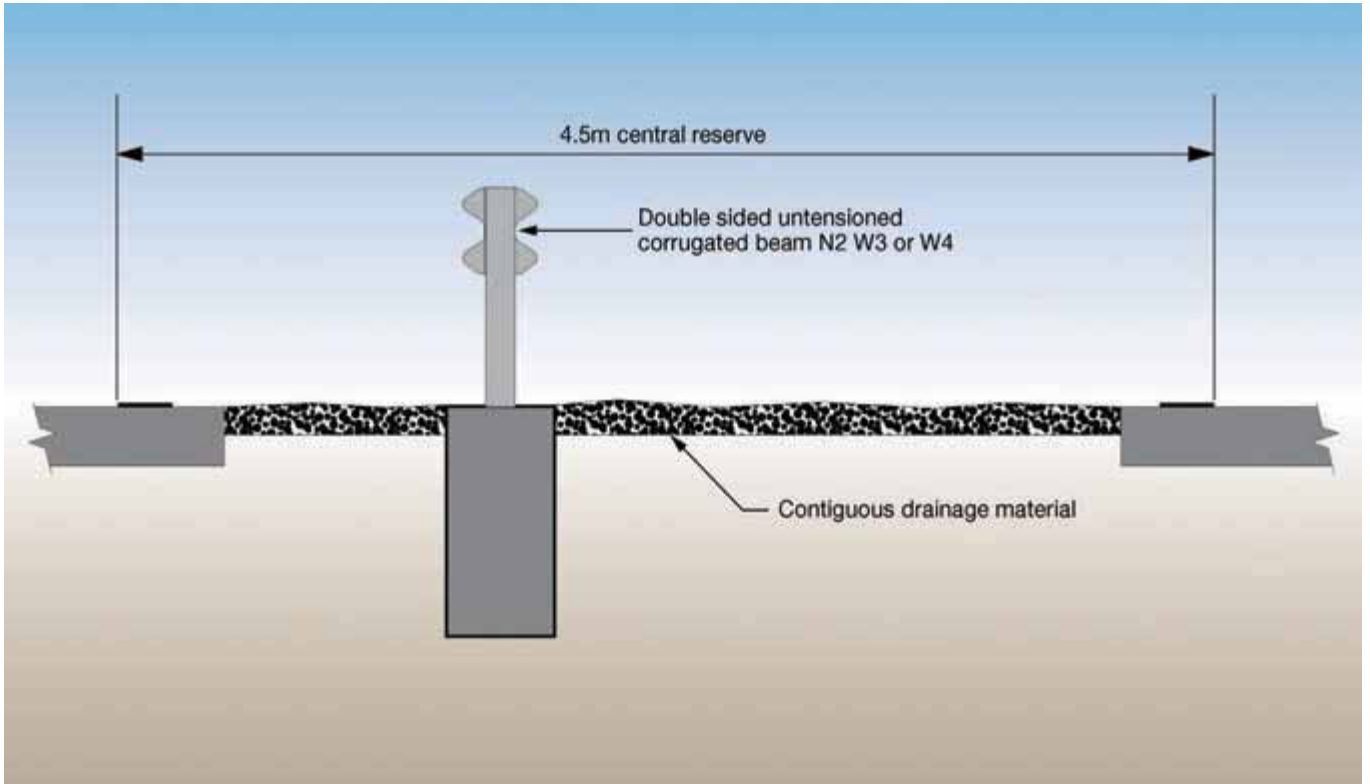


Figure 3.3: Layout C - Soft central reserve with double sided uniaxially corrugated beam barrier, socketed foundation.

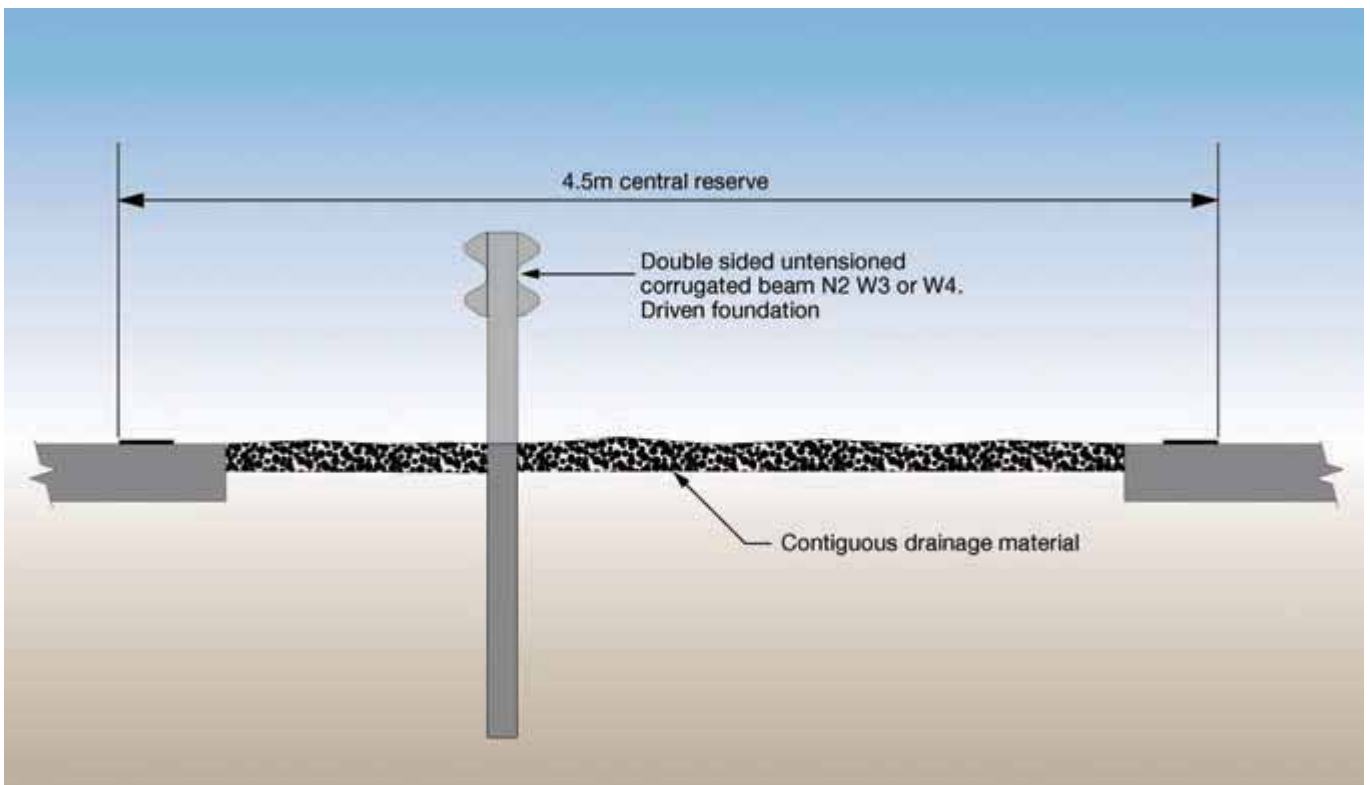


Figure 3.4: Layout C - Soft central reserve with double sided uniaxially corrugated beam barrier, driven post foundation.

3.3 Layouts with lighting columns

The three layouts with lighting columns in table 3.3 were costed (figures 3.5 to 3.8). All layouts assume a minimum set back of 1.2 metres and no departures from standard on working width. For simplicity, central reserve widths are considered in increments of 0.5 metres.

Table 3.3 – Central reserve layouts with lighting columns

Layout	Description	Performance	Min. central reserve	Figure
D	Wide profile CSB with integral cable trough, lighting columns mounted on top, fully hardened central reserve	H2 W3 Higher containment	3.5 metres	3.5
E	Dual standard profile CSB, lighting columns installed between the barriers, fully hardened central reserve	H2 W2 Higher containment	4.5 metres	3.6
F	Two single sided untensioned corrugated beam barriers, lighting columns installed between barriers, soft central reserve	N2 W4 Normal containment	6.0 metres	3.7 Socketed post foundation 3.8 Driven post foundation

Layout D represents an optimised solution with lighting columns fixed directly onto a wide CSB profile. This layout is costed with a fully hardened central reserve width of 3.5 metres.

Layout E consists of two parallel surface mounted standard profile CSB profiles. The central reserve is assumed to be fully hardened for ease of construction. This layout provides higher containment but the low working width of the barriers allows the central reserve width to be maintained at the standard 4.5 metres.

Layout F with lighting columns installed between two single sided deformable barriers represents a typical existing UK motorway and trunk road layout. The central reserve width is increased to 6.0 metres to accommodate the W4 working width class of the single sided N2 barriers. Alternatively this layout could be provided with higher containment using the two-rail untensioned corrugated beams (H2 W4 or W5) costed in the Stage 1 study. The surface finish in the central reserve is assumed to be contiguous drainage filter material.

All steel barriers have been costed with both socketed concrete and driven post foundations. Socketed post concrete foundations provide for easier replacement of the barrier following damage. Driven posts provide a cheaper foundation for steel barriers but are dependent upon good ground conditions in the central reserve.

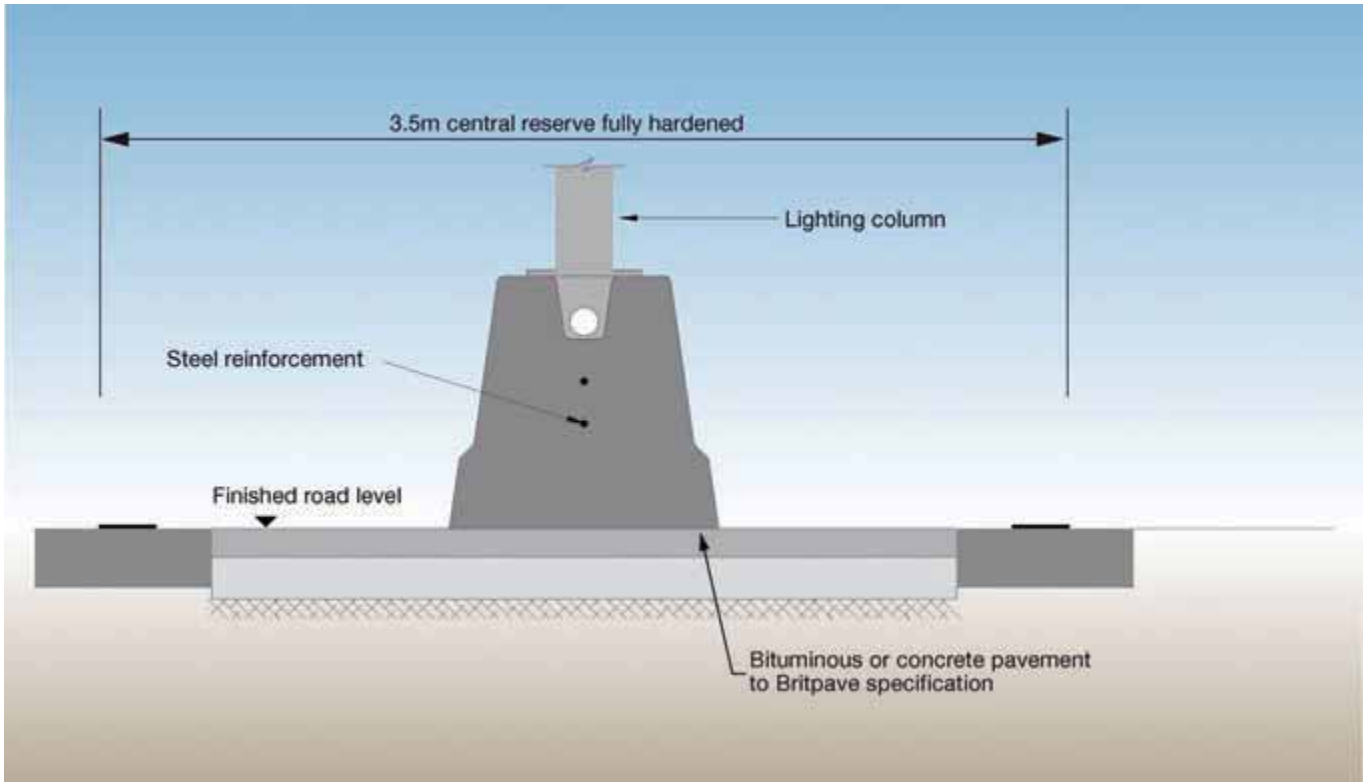


Figure 3.5: Layout D - Wide profile CSB with integral cable trough and lighting columns, fully hardened central reserve.

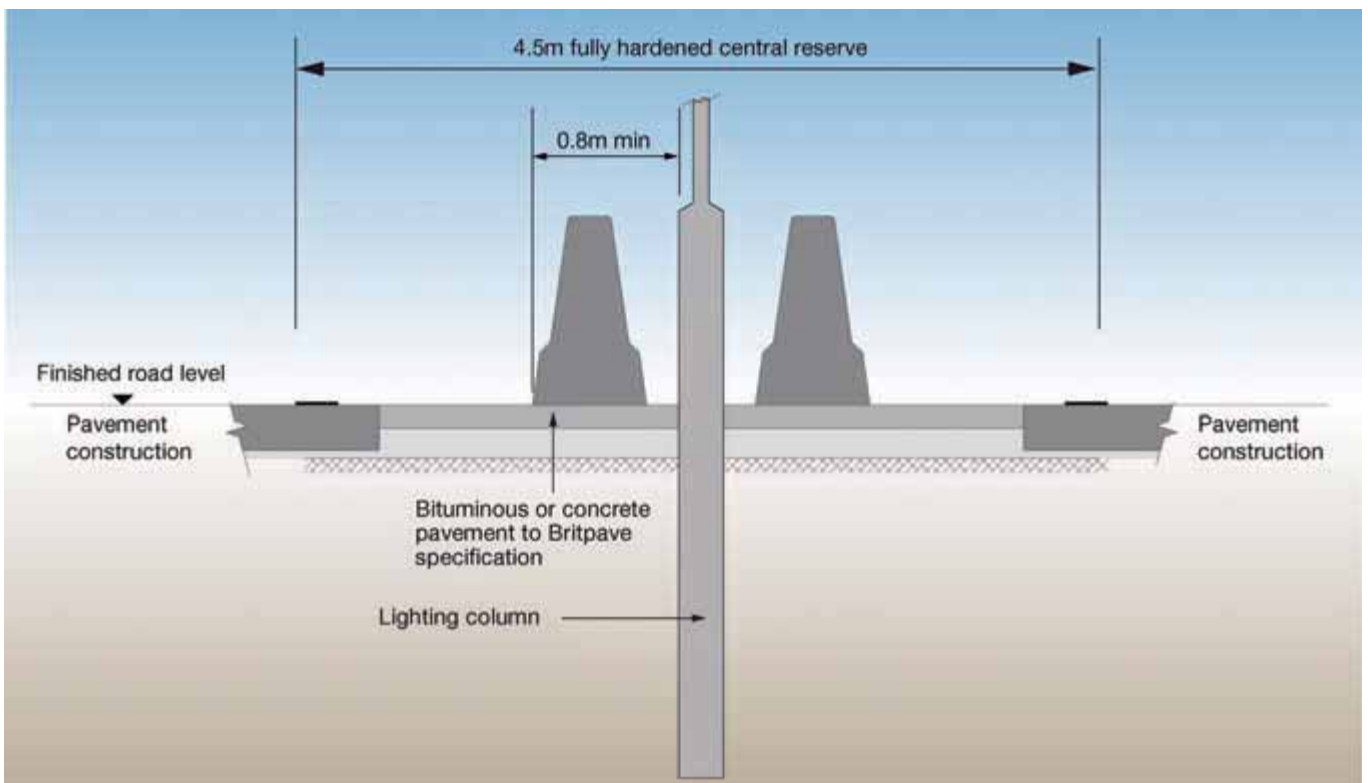


Figure 3.6 : Layout E - Dual standard profile CSB with lighting columns, fully hardened central reserve.

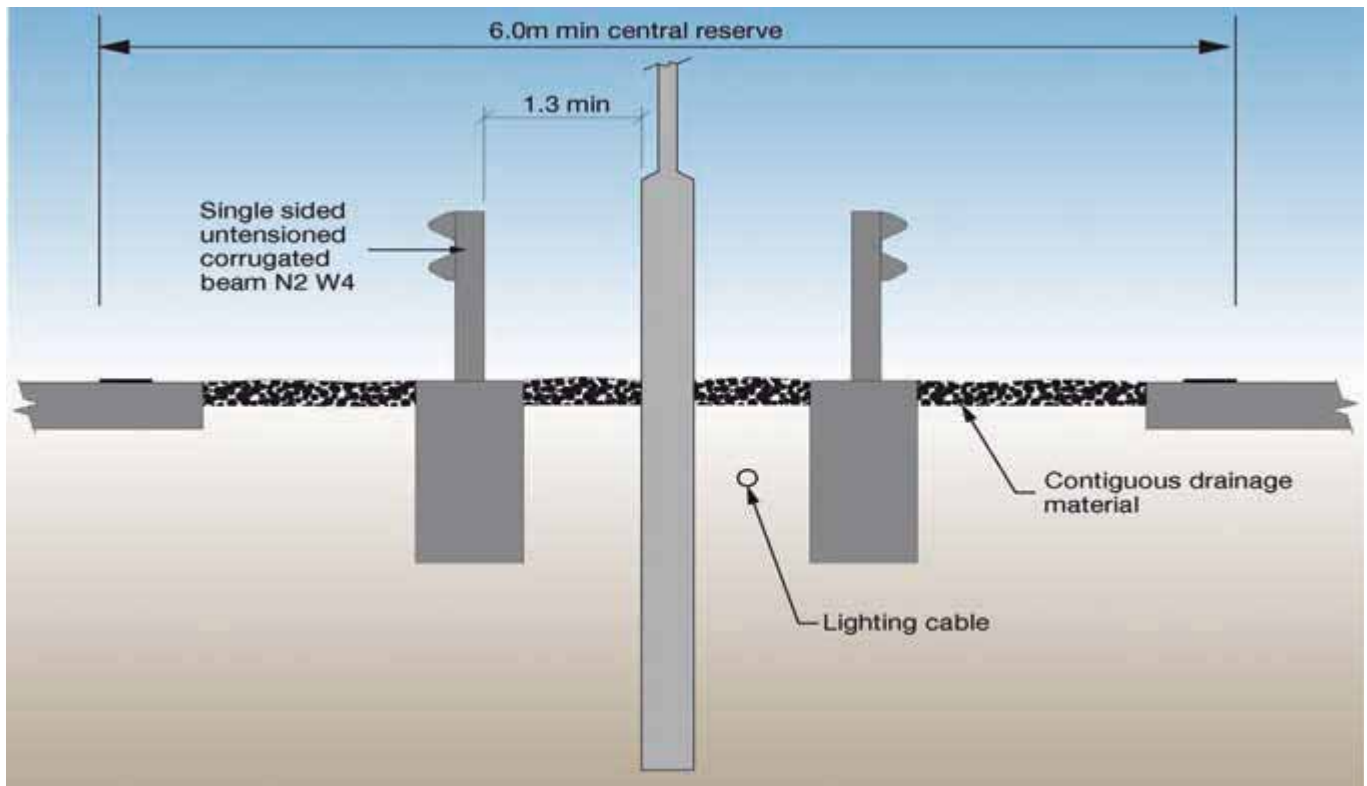


Figure 3.7: Layout F - Two single sided-untensioned corrugated beam barriers, socketed foundations, with lighting columns, soft central reserve.

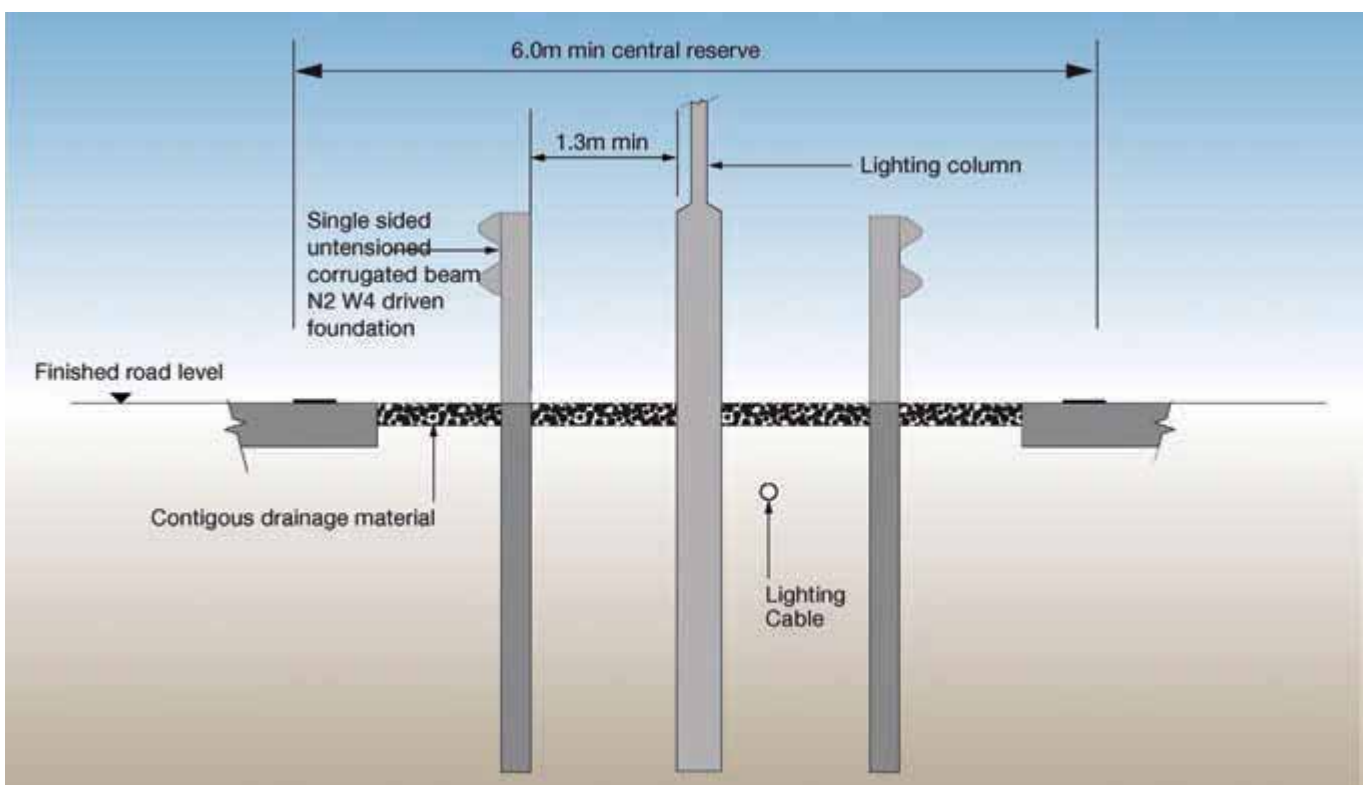


Figure 3.8: Layout F - Two single-sided untensioned corrugated beam barriers, driven post foundations, with lighting columns, soft central reserve.

3.4 Exclusions

The following items have been excluded from the costing:

- Land costs (and savings from reduced land-take).
- Drainage.
- Structures, bifurcations, tapers, etc.
- Terminals.
- Site specific conditions.

The costs of the lighting columns, mountings and independent foundations has also been excluded. Costs are provided for the barriers and central reserve construction.

4 COSTS

A detailed spreadsheet has been developed from cost data provided by industry. Since the data containment in the spreadsheet is commercially sensitive, only a summary is present in this report.

The costs used in this report were obtained in March 2007 from industry suppliers and are supplier costs for installation of the barrier system by a specialist installer. No account is taken for main contractor on costs.

4.1 General data

For typical cost ranges for the untensioned corrugated beam barrier systems and concrete step barrier, refer to the tables in section 4 of the Stage 1 report.

Some of the features included in the comparative prices such as central reserve construction will be true for both CSB and steel barrier options. Although the detail of the central reserve assumes a basic construction, any adjustment would be true for both options.

Typical cost ranges for the 100mm thick surface finishes (excluding foundation, where applicable) considered at Stage 2 are given below:

Table 4.1.1 – General data for central reserve surfacing

Central reserve surface finish (100 mm thick)	
Bituminous pavement	£15 to £20 per m ²
Concrete pavement	£8 to £9 per m ²
Contiguous drainage material	£2 to £3 per m ²
Soil and seed	£2 to £3 per m ²

The method of construction chosen for laying the central reserve will cause variations in the cost. Hand laying small sections or narrow strips of surfacing is expensive.

More costs effective methods of construction in bitumen include:

- Laying the central reserve surfacing as a continuation of the carriageway or hard strip construction.
- Laying the central reserve full width in one pass.

For installation of surface mounted CSB, a common method of construction is to extend the screed of the base course to provide the foundation for the barrier, then lay the surface course up to the face of the barrier.

No allowance has been made in the costs for excavation of hard material for installation of steel barrier or lighting column foundations. If hard material is encountered in the central reserve, costs of excavation are typically £25 to £30 per m³. Dealing with hard material can have a significant impact on the installation of posts for steel barriers, both in cost and time.

4.2 Summary

A summary of the costs calculated for the central reserve layouts considered in the study is given in table 4.2.1. A summary of costs calculated for the central reserve layouts with lighting columns is provided in table 4.2.2.

Table 4.2.1 – Basic costs per linear metre

	Description	Performance	Comparative cost per linear metre of central reserve Average $\pm 10\%$			
			Driven post foundation	Socketed post foundation	CSB with flexible composite surface	CSB with rigid composite surface
A	Fully hardened central reserve with standard CSB	H2 W2			£120	£94
B	Standard CSB with minimum paved surface and remainder soft central reserve	H2 W2			£114	£98
C	Soft central reserve, untensioned corrugated beam	N2 W3 or W4 ⁽¹⁾	£77	£83		
		H2 W4	£132	£157		

⁽¹⁾4m post centres

Table 4.2.2 – Costs for central reserve layouts with lighting columns

	Description	Performance	Comparative cost per linear metre of central reserve Average $\pm 10\%$			
			Driven post foundation	Socketed post foundation	CSB with flexible composite surface	CSB with rigid composite surface
D	Wide profile CSB with integral cable trough, lighting columns mounted on top, fully hardened central reserve	H2 W3			£185	£155
E	Dual standard profile CSB, lighting columns, fully hardened central reserve	H2 W2			£207	£169
F	Untensioned corrugated beam barriers, lighting columns, soft central reserve	N2 W4 ⁽¹⁾	£96	£109		
		H2 W4	£142	£167		

⁽¹⁾ 4m post centres

4.3 Discussion of costs

4.3.1 Post spacing

Costs have been calculated based on a post spacing of 4 metres for the N2 barrier systems. Where post spacing is reduced to 2.4 metres, costs for the N2 systems should be increased by 7 per cent for driven post foundations and 14 per cent for socketed foundations.

H2 containment steel barrier systems have been costed with a post spacing of 2 metres.

4.3.2 Central reserve surfacing

The costs show that hardening the central reserve with a flexible pavement is more expensive than using rigid concrete. While, as expected, the soft central reserve is the cheapest surfacing, it should be noted that this does not follow the HA preference for a fully hardened low maintenance central reserve.

It is of note that layout B with rigid composite surface in a 4.5m central reserve is more expensive than layout C which has a rigid surface and 3m central reserve:

A Fully hardened central reserve (concrete) with standard CSB	£94 per m
B Standard CSB with minimum paved surface (concrete) and remainder soft central reserve	£98 per m

This clearly shows cost savings in the reduced central reserve width of layout A (3 metres) compared to layout B (4.5 metres), even without considering land costs.

Fully hardened central reserves offer efficiency in construction, minimising the number of processes involved in laying the surfacing materials.

4.3.3 Central reserve layout

Steel barriers have been costed with socketed concrete foundations and driven post foundations. Driven posts provide a cheaper foundation for steel barriers but are dependent on good ground conditions in the central reserve.

Layout C, double sided untensioned corrugated beam barrier (N2 W4) in 4.5 metre soft central reserve, was the cheapest layout considered. However the following points should be noted about this layout:

- Only provides N2 containment performance.
- Requires wider central reserves than options using CSB.
- Requires maintenance in central reserve.

Layout C with H2 containment performance using a pair of two-rail untensioned corrugated beam barriers (H2 W4), was the most expensive central reserve layout (without lighting columns), at £157 per linear metre of central reserve (socketed foundations), even with a soft finish to the central reserve.

Of the CSB options considered in the study, layout A with rigid surfacing is the most economic: Fully hardened (concrete) 3 metre wide central reserve with standard CSB at £94 per metre is the most economic higher containment performance layout. The low W2 working width

and narrow central reserve required for CSB allows provision of H2 containment in areas where steel systems cannot be installed without a departure from standard.

Higher containment performance with fully hardened central reserve can therefore be provided by CSB for around an 18 per cent increase in capital cost compared to an N2 deformable system, with driven posts in soft central reserve, and a saving of 67 per cent compared to the H2 deformable system with socketed foundations.

4.3.4 Central reserve with lighting columns

Layout F, single sided untensioned corrugated beams (N2 W4) with lighting columns in 6.0 metre soft central reserve was found to be the cheapest layout with lighting columns. However the following points should be noted about this layout:

- Only provides N2 containment performance.
- Requires wider central reserves than options using CSB.
- Requires maintenance in central reserve.

The most expensive layout considered was layout E at £209 per linear metre of central reserve with flexible surfacing. This layout is dual surface mounted CSB with a fully hardened central reserve.

The most economic CSB layout with lighting columns is layout D: Wide profile CSB with integral cable trough, lighting columns mounted on top, fully hardened central reserve (concrete) at £155 per metre. This is a higher containment performance layout, and can be installed in a narrow central reserve of 3.5 metres, without departure from standard. Although layout F, the steel H2 system in soft central reserve can be installed for £142 per metre with driven posts, this layout requires a central reserve width of at least 6 metres to accommodate the working width of the deformable system.

The costs for wide concrete step barrier with integral cable trough (Layout D) are conservatively high. The barrier itself provides the foundation for the lighting columns and cost savings using this system can be realised by:

- No requirement for independent lighting column foundations.
- Reduced requirement for ducts and draw pits.
- Use of non-armoured cable in the trough.

The extra over cost for lighting column mountings for wide CSB profiles is £9 per metre, assuming 45 metre centres. However, costs for the lighting columns themselves and foundations (Layouts E and F) have not been included in this study. For layout D, the lighting column, mounted on top of the barrier will be shorter than lighting columns required for E and F.

5 CONCLUSIONS

Stage 1 of this study developed basic comparative costs for central reserve barrier systems. This report is for Stage 2 of the study and considers the influence of different central reserve layouts, and central reserves where lighting columns are installed. This report follows, and should be read in conjunction with, the Stage 1 report, which includes descriptions of the different barrier systems costed for Britpave.

This report investigates the influence on cost of changing the following conditions in the central reserve:

- Surface treatment – paved surface, soft central reserve.
- Width of central reserve.
- Lighting columns.

by deriving cost ranges for six typical central reserve layouts are derived:

- A Fully hardened central reserve with standard CSB.
- B Standard CSB with minimum paved surface.
- C Soft central reserve, with untensioned corrugated beam barrier.
- D Wide profile CSB with integral cable trough, lighting columns mounted on top, fully hardened central reserve.
- E Dual standard profile CSB, lighting columns installed between the barriers, fully hardened central reserve.
- F Two single sided untensioned corrugated beam barriers, lighting columns installed between barriers, soft central reserve.

For the purposes of the costing exercise, the site was assumed to be 5km of rural motorway, balanced carriageway on embankment. Costs per linear metre were calculated for each layout using data obtained from industry. In summary, the range of costs for each layout is given in tables 5.1 and 5.2.

Table 5.1 – Cost range for central reserve layouts

	Description	Performance	Comparative cost per linear metre of central reserve. Average $\pm 10\%$			
			Driven post foundation	Socketed post foundation	CSB with flexible composite surface	CSB with rigid composite surface
A	Fully hardened central reserve with standard CSB	H2 W2			£120	£94
B	Standard CSB with minimum paved surface and remainder soft central reserve	H2 W2			£114	£98
C	Soft central reserve, untensioned corrugated beam	N2 W3 or W4	£77	£83		
		H2 W4	£132	£157		

Table 5.2 – Cost range for central reserve layouts

	Description	Performance	Comparative cost per linear metre of central reserve. Average $\pm 10\%$			
			Driven post foundation	Socketed post foundation	CSB with flexible composite surface	CSB with rigid composite surface
D	Wide profile CSB with integral cable trough, lighting columns mounted on top, fully hardened central reserve	H2 W3			£185	£155
E	Dual standard profile CSB, lighting columns, fully hardened central reserve	H2 W2			£207	£169
F	Untensioned corrugated beam barriers, lighting columns, soft central reserve	N2 W4	£96	£109		
		H2 W4	£142	£167		

The cost ranges given for layouts A, B, D and E reflect variations in the surfacing for the central reserve in those options.

While layouts C and F with N2 containment performance were found, as expected, to be the cheapest, these layouts do not reflect current HA standards and guidance for central reserves in motorways. These layouts were priced with a post spacing of 4 metres. Where post spacing is reduced, the cost per linear metre should be increased accordingly.

All the CSB layouts provide H2 (higher containment) performance and W2 or W3 working width.

Reducing the width of the central reserve was found to reduce costs. This shows clear benefit for use of the rigid CSB barrier profiles instead of deformable barrier systems. Hardening the central reserve with rigid concrete pavement was found to be more cost effective than flexible bituminous pavement.

The CSB layouts take advantage of the low working width of rigid barrier systems to reduce the central reserve width. This brings savings both in volumes of material required to surface the central reserve and also in reduced land-take. Land costs have not been included in this study but will be a significant factor on motorway widening schemes and in a new-build scenario.

Of the CSB options considered in the study, Layout A is the most economic: Fully hardened (concrete) 3 metre wide central reserve with standard CSB at £94 per metre.

The most economic CSB layout with lighting columns is layout D: Wide profile CSB with integral cable trough, lighting columns mounted on top, fully hardened central reserve (concrete) at £155 per m.

Costs for the lighting columns themselves and foundations have not been included in this study.

Principal conclusions of the Stage 2 study are as follows:

- Providing H2 containment performance with CSB profiles is more economic than using deformable steel higher containment systems.
- Use of CSB profiles brings cost savings in reduced central reserve width – land costs and surfacing costs.
- N2 deformable steel barriers with soft central reserve, offer a cheap, inferior performance option with high maintenance requirements.
- Hardening the central reserve with concrete is more cost effective than using flexible bituminous pavement.

Steel barriers have been costed with driven post and socketed concrete foundations. Socketed concrete foundations provide for easier replacement of the barrier following damage. Driven posts provide a cheaper foundation for steel barriers but are dependent on good ground conditions in the central reserve.

The costs for a wide concrete step barrier with integral cable trough (Layout D) are conservatively high. The barrier itself provides the foundation for the lighting columns. Cost savings using this system can be realised by:

- No requirement for independent lighting column foundations.
- Reduced requirement for ducts and draw pits.
- Use of non-armoured cable in the trough.
- Shorter lighting columns (mounted on top of barrier). The narrow central reserve width required allows installation of CSB and wide CSB profiles in locations where steel barriers could not be provided without a departure from standard.

5.1 Future studies

It is intended that a further study (Stage 3) will be undertaken to examine the influence on costs of items such as:

- Transitions.
- Connections to structures.
- Terminals.
- Bifurcation.
- Drainage details.
- Emergency crossing points.



The British In-situ Concrete Paving Association



www.britpave.org.uk

BP/38 CONCRETE STEP BARRIER STUDIES

Barrier cost comparison Stage 2 of 3

BRITPAVE

Riverside House | 4 Station Approach | Blackwater | Camberley | Surrey GU17 9AB
T: +44 (0)1276 33160 | E: info@britpave.org.uk