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The British In-situ Concrete Paving Association

BARRIER COST COMPARISON

Britpave

Concrete Step Barrier Studies

Barrier Cost Comparison: Stage 1

Basic barrier costs

June 2008

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The British In-situ Concrete Paving Association

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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 on the highway network.

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.

This study has derived basic costs for three central reserve barrier systems, installed on a like-for-like basis, given the difference in performance levels of the systems. The three barrier systems considered were:

- Standard profile surface mounted concrete step barrier H2 W2.
- Untensioned double-sided corrugated beam N2 W3 or W4.
- Untensioned two-rail single-sided corrugated beam H2 W4 or W5.

The barriers (and foundation conditions) considered in this study have been successfully tested to BS EN 1317. However, the two steel barrier systems do not meet the requirements of TD 19/06.

Post centres for the steel safety barriers have been assumed to be 4 metres. This is the greatest spacing provided by approved suppliers. In general posts are at reduced spacing, down to a minimum of 0.8 metres.

For the purposes of the cost comparison the site is assumed to have the following features:

- 5 km of rural motorway.
- 4.5 metre wide central reserve.
- Hard and soft central reserve details.
- Balanced carriageway on embankment.
- No lighting columns in central reserve.

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. Steel barriers have been costed with both socketed concrete foundations which is the preferred installation type by by highway network owners and driven posts. The socketed foundation type provides for easier replacement of the barrier following impact damage or routine maintenance. Costs for steel barrier installed using driven post foundations have also been determined.

Basic costs for the barrier systems per linear metre were derived using data obtained from industry in March 2007. No costs are included for central reserve details. This will be the subject of the Stage 2 report. In summary the basic costs for the barrier systems are given in the table below.

Table 1 – Basic costs per linear metre

Barrier system	Basic cost per linear metre Average ± 10%
Standard profile surface mounted concrete step barrier, H2 W2 (figure 3.1)	£55
Untensioned double-sided corrugated beam, in socketed foundations N2 W3 or W4 (figure 3.2)	£51
Untensioned double-sided corrugated beam, with driven post foundations N2 W3 or W4 (figure 3.3)	£45
Untensioned two-rail single-sided corrugated beam, in socketed foundation H2 W4 or W5, 2 No. barriers, hard central reserve.	£126 (2 No. barriers at £63/m)
Untensioned two-rail single-sided corrugated beam, with driven post foundations, H2 W4 or W5, 2 No. barriers, soft central reserve	£100 (2 No. barriers at £50/m)

This study shows that H2 W2 surface mounted CSB may be provided for a cost comparable to the N2 W3 or W4 deformable systems installed with socketed foundations, which offer inferior containment and working width performance.

Whilst the cost difference is increased if driven post foundations are adopted it must be noted that the post centres are assumed to be at 4 metres, which is greater than usual, Where post centres are closer than 4 metres, costs should be increased. This increase is 14 per cent for 2.4 metre centres with socketed foundations and 7 per cent for driven posts. If the post spacing is reduced below 2.4 metres then a further 7 per cent increase should be applied to the costs.

Driven posts are not the preferred solution for highway network owners. The use of driven posts is dependent on good ground conditions in the central reserve, results in increased maintenance and remedial work following impact damage.

The report concludes that adoption of a concrete step barrier will reduce the risk to the maintaining workforce because fewer interventions are required to maintain or repair the concrete step barrier during its working life.

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.

1.1 Background

In 2004 the Highways Agency commissioned a study[1] from the Transport Research Laboratory (TRL) which examined the whole life cost of steel and concrete barriers in service on the M25, including accident statistics. Following this study The Highways Agency issued Interim Advice Note IAN 60/05 in January 2005, which raised the containment performance level for motorway central reserve barriers from N2 to H2 (to BS EN 1317), and also specified the use of concrete barriers in the central reserve. Subsequently TD 19/06 came into force in October 2006 requiring installation of concrete barriers minimum containment level H1 in central reserves of motorway with greater than 25000 AADT.

In April 2006 Britpave (The British In Situ Concrete Paving Association) successfully crash tested the Surface Mounted Concrete Step Barrier (CSB) to BS EN 1317 with containment performance class H2 and working width class W2. The Surface Mounted CSB was added to the Highways Agency Approved List of Road Restraint Systems.

Surface Mounted CSB offers savings in construction costs compared to embedded CSB, without compromising the containment performance class. However, a number of questions relating to the costs of alternative barrier systems have been raised with Britpave by the Highways Agency and its MAC (Maintenance Area Contractor) teams.

This study has been carried out in response to these queries.

1.2 Scope and purpose

This report considers the cost of installing three different vehicle restraint systems in motorway central reserve. The objective of the analysis was to achieve as close as possible a like-for-like costing per km between modern concrete and steel systems, given the differences in performance of the barriers.

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.

The barriers (and foundation conditions) considered in this study have been successfully tested to BS EN 1317.

For the purposes of obtaining realistic unit costs for the barrier systems, a number of scenarios could be considered, for example:

- Basic cost of barrier system, to provide a given level of performance.
- Variations in central reserve conditions e.g. width, level differences, surface treatment, lighting columns.
- Additional costs at terminals, tapers and bifurcations to accommodate bridge piers etc.

[1] Williams, G. L., Whole Life Cost-Benefit Analysis for Median Safety Barriers PR/SE/903/04 HA Task Ref No. 3/372/R22.

This initial Stage 1 study will concentrate on item 1 and will generate basic costs for the barrier systems. There are a number of items which have been excluded from the basic costing study and these are detailed in Section 3.3; they include drainage, lighting columns, terminals, bifurcations at structures and land-take.

Costs have been built up from first principles considering the individual components of each of the barrier systems. Construction methods and installation rates have also been included in the analysis.

This study does not consider 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. However, whole life costs and broader sustainability and safety issues are briefly discussed, though not quantified, in Section 5.

1.3 Cost data

Rates for steel and concrete barrier installation were obtained from a variety of UK sources in March 2007. In many cases the data is commercially sensitive and this report therefore presents only a summary of the information given by specialist barrier suppliers and contractors.

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 barrier systems considered for this study are shown in table 2 below:

Table 2 – Barrier system used for cost comparison

Barrier system	Containment performance class	Working width class	Notes
Britpave Surface Mounted CSB – standard profile	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. Two barriers will be required
Untensioned corrugated beam (Double-sided)	N2	W3 or W4	Does not meet TD 19/06 requirement for H1 containment or concrete barrier

A brief description of the systems is given below. Full details can be obtained from the promoter. All these systems appear on the Highways Agency listing of Approved Road Restraint Systems.

Both driven post foundations and socketed foundations have been assessed for steel barriers. Driven post foundations are more prevalent on the highway network, but suitability is dependent on ground conditions in the central reserve. 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 Surface Mounted CSB

Standard profile Surface Mounted CSB is a slipformed concrete barrier 900mm high above road level with an overall base width of 542mm. The barrier is double-sided and 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.

This is a rigid concrete barrier providing H2 containment performance with a working width class of W2 (≤ 0.8 metres).

Figure 2.1.1 Concrete Step Barrier.

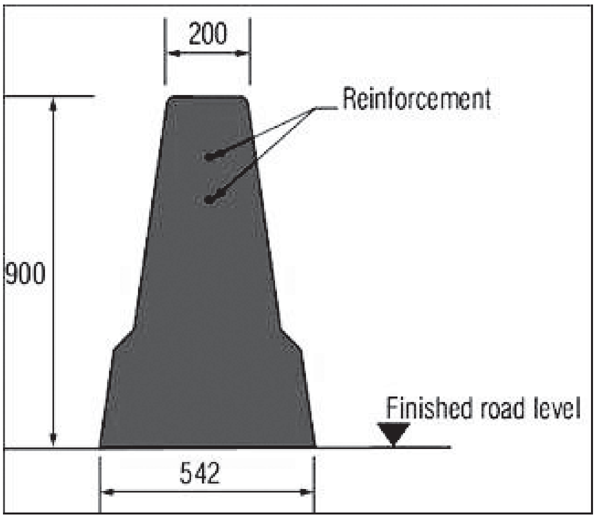

Figure 2.1.2 Surface Mounted Concrete Step Barrier.

2.2 Untensioned Corrugated Beam

Untensioned deformable steel barrier systems are available to provide a range of containment performance and working width classes. Work has been done by manufacturers to minimise the number of components in the systems in order to facilitate installation and maintenance.

For the purposes of this study, the steel barrier has been considered with both driven posts and socketed post foundations. Socketed post foundation type provides for easier replacement of the barrier following damage and is the preferred solution of highway network owners.

Examples of untensioned corrugated beam systems include the Corus Vetex range and Hill & Smith's Flex-Beam.

Two levels of containment performance were considered for the study:

a) Higher containment H2 W4 or W5

Corus Vetex is available as a higher containment system providing H2 containment performance and working width W4 (£1.3 metres) with posts spaced at 2 metre centres. The barrier has two rails, a lower rail to reduce the ASI for small cars and an upper rail to provide containment.

Figure 2.2.1 Corus Vetex H2 W4 (photo from Corus presentation).

The Hill & Smith Flex Beam Plus provides H2 containment and working width W5 (≤ 1.7 metres) with posts spaced at 2 metre centres.

These are single-sided barriers, designed to withstand impact from one face. For application in the central reserve, two barriers would therefore be required.

b) Normal containment N2 W3 or W4

Corus Vetex is available as a double-sided deformable barrier providing N2 containment performance and working width class W3 (≤ 1 metre) with posts spaced at 4 metre centres.

Figure 2.2.2 Corus Vetex N2 W3 double-sided barrier (photo from Corus presentation).

Hill & Smith Flex-Beam is available as a double-sided deformable barrier providing N2 containment performance and working width class W4 (≤ 1.3 metres) with posts spaced at 4 metre centres.

Although post spacings of 4 metres have been assumed for the cost analysis, in practice posts are often installed at a reduced interval, down to a minimum of 0.8 metres.

N2 barriers do not meet the containment performance specified by TD 19/06. However, the N2 barrier has been priced to provide a comparison with the central reserve barrier installations traditionally installed on the motorway and trunk road network.

3 METHODOLOGY

Typical cross sections were drawn for each of the barriers to be priced. The typical cross section for surface mounted concrete step barrier is shown in Figure 3.1. The typical cross section with N2 steel barrier is shown in Figure 3.2 for socketed foundations and Figure 3.3 for driven post foundations.

Costs have been built up from first principles considering the individual components of each of the barrier systems e.g. foundations, posts, material quantities. The construction methods and installation rates have also been included in the analysis.

Rates for steel and concrete barrier installation have been obtained from a variety of UK sources, including:

- Published rates.
- Concrete barrier specialist slip form contractors.
- Main contractors.
- Steel barrier installers.
- Highways Agency framework agreements.

3.1 The site

For the purposes of the cost comparison the site is assumed to have the following features:

- 5 km of rural motorway.
- 4.5 metre wide central reserve.
- Hard and soft central reserve details.
- Balanced carriageway on embankment.
- No lighting columns in central reserve.

3.2 Pavement construction in central reserve

The central reserve construction has been priced for both hardened and soft finish. However, hardened surfacing is considered to reflect current good practice in highway design, reducing the need for maintenance work in the central reserve. The cost implications of different surface treatments in the central reserve, are addressed in the Stage 2 study.

3.3 Exclusions

The following items have been excluded from the costing:

3.3.1 Drainage

The site is assumed to be balanced carriageway on embankment; therefore no central reserve drainage is required. However, it is considered reasonable to exclude drainage as it is common to all barrier types i.e. if a drain was required for a CSB option, then it would be required with a steel barrier also.

3.3.2 Lighting columns

Installation of lighting columns in the central reserve has been excluded from the initial study. This initial costing analysis will look at standard profile CSB. Stage 2 of this study will build on the work of Stage 1 of the study and develop alternative model schemes and specific details, which will include installation of lighting columns.

3.3.3 Structures

The impact of structures on the cost of the central reserve barrier, e.g. bifurcations, has been excluded from Stage 1 of the study, but will be addressed in later stages.

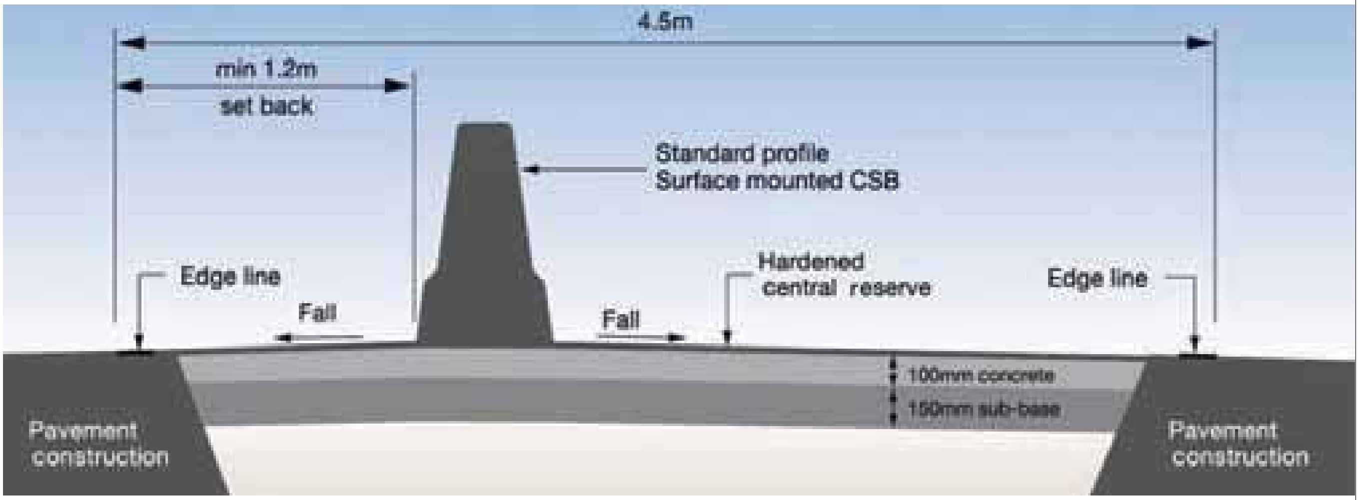

Figure 3.1: Surface mounted CSB in hardened central reserve.

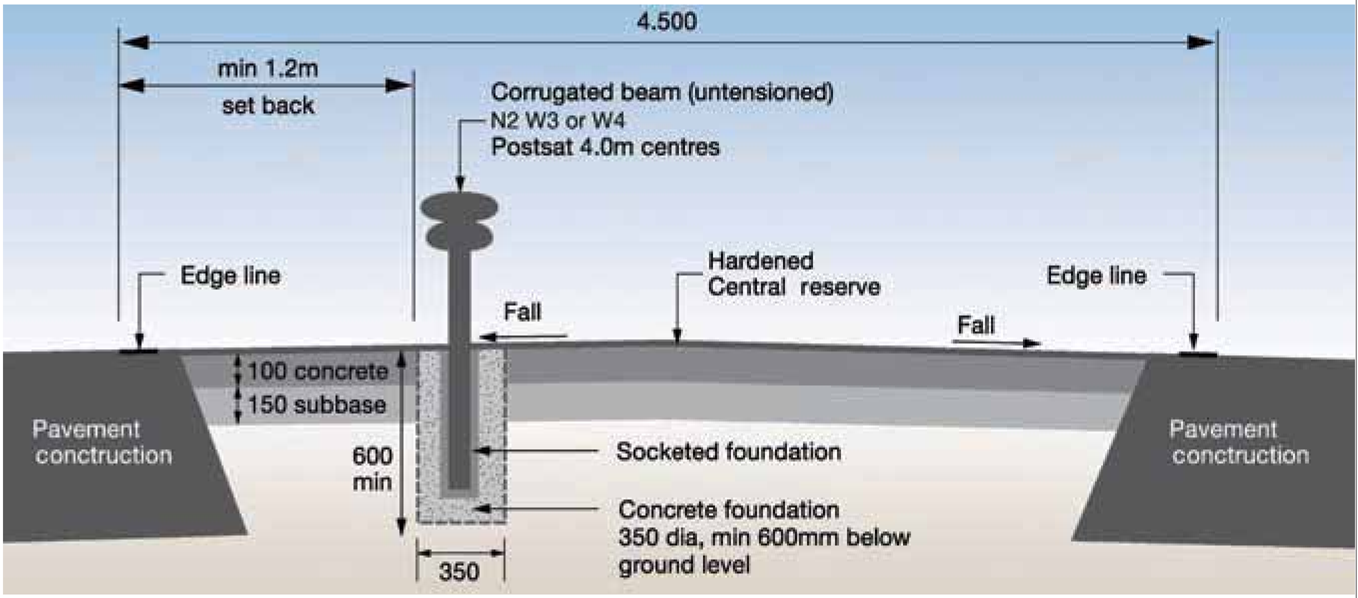

Figure 3.2: Untensioned corrugated beam in hardened central reserve with socketed post foundations.

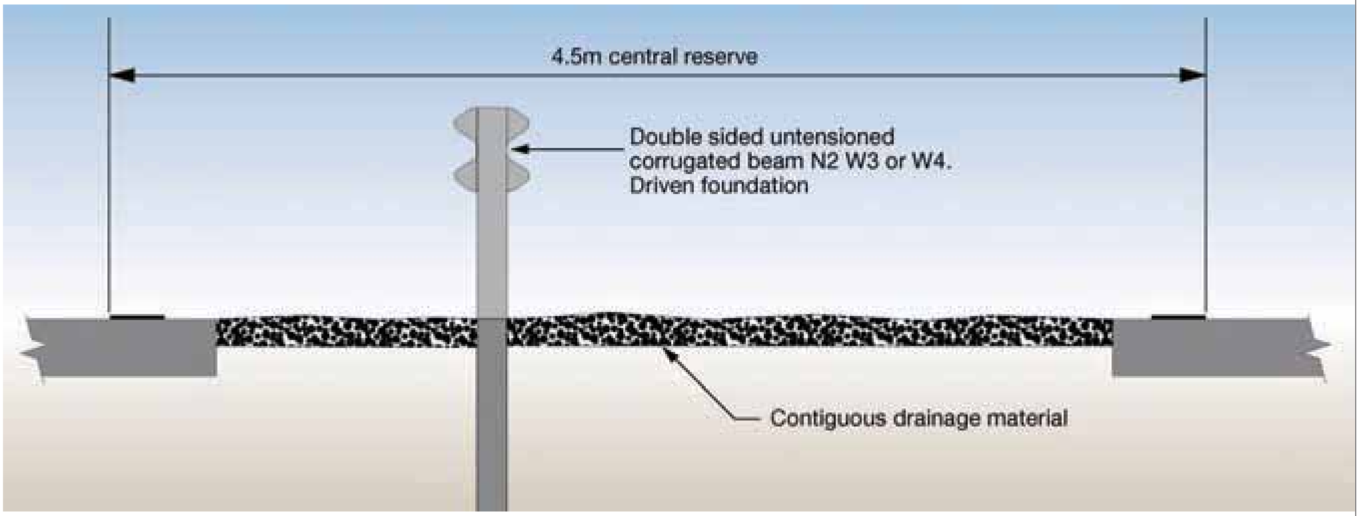

Figure 3.3: Untensioned corrugated beam with driven post foundations.

3.3.4 Terminals

Terminals and end details have not been included in the development of the basic costs given in this report. It is intended that these will be addressed in a later stage of the study.

3.3.5 Land-take

A central reserve width of 4.5 metres has been assumed for the analysis. The minimum required width of central reserve varies with each barrier system. It is intended that the cost implications of this will be addressed at a later date.

3.4 Information from industry

As part of this study, Arup met with specialist slip form contractors and steel barrier installers to discuss in detail methods of installation.

Information was provided on:

- Labour – including gang size and composition, engineering and support staff.
- Plant & machinery costs – including transport to and from site.
- Material costs – all components of the steel and concrete barrier systems.
- Volumes of materials handled.
- Output rates.

3.4.1 CSB construction

The barrier costed in this study is the surface mounted CSB. This is extruded directly onto a paved concrete or asphalt surface and has no requirement for the independent concrete cradle foundation, which was a feature of earlier CSB designs.

From the information provided by industry it is clear that the efficiency of the slip form process is controlled by the rate of supply of concrete to the site, rather than by the theoretical output of the paver.

The typical volume of ready mixed concrete supplied for concrete step barrier construction on site ranges between about 90m^3 and 110m^3 a day. This corresponds to a paved length of typically between 230 and 300 linear metres in an eight hour shift for standard profile CSB. The maximum volume of concrete quoted was 130m^3 per day, equivalent to paving 400 linear metres of barrier.

The method of placing steel reinforcement ahead of the paving operation varies between contractors; some prefer to use continuous strand reinforcement, others weld together H20 bars. The range of rates provided by contractors reflected these variations in construction technique.

3.4.2 Steel barrier installation

There are a number of foundation options for untensioned corrugated beam systems, depending on ground conditions in the central reserve. These are typically:

- Driven posts.
- Discrete concrete foundations.
- Continuous concrete foundation.
- Socketed concrete foundations.

For the purposes of this costing exercise driven post and socketed concrete foundations have been assumed. While driven posts would prove a cheaper option, use of these is dependent on good ground conditions in the central reserve. Use of socketed foundations is preferred by The Highways Agency as they enable easier replacement of damaged barrier following impact. This type of foundation is in widespread use on the UK road network.

3.5 Programme

The impact on construction programme from selecting concrete rather than steel central reserve barrier details has not been included in the basic costs. However, it is noted that the construction output in terms of linear metres of barrier system installed per day is generally higher for CSB than for the steel systems considered.

4 COSTS

A detailed comparison spreadsheet has been developed from the data provided by industry. Since the data contained in this spreadsheet is commercially sensitive, only a summary of the data is presented in this report.

The costs for supply and installation of concrete barrier used in this report have been provided by licenced CSB suppliers. Costs for supply and installation of steel barrier systems were also provided by specialist installers.

4.1 General data

The following tables give typical ranges for the items used to build up the basic costs for the surface mounted Concrete Step Barrier and untensioned corrugated beam barrier systems:

Table 4.1.1 – General data for surface mounted CSB

Surface mounted concrete step barrier	
Mobilisation/demobilisation	Depends on distance, but typically between £2,000 and £2,500
Other establishment costs	As applicable, but up to a value of £5,000
Gang size	Typically between 10 and 12 operatives including engineering supervision
Gang cost including equipment	Between £5,000 and £5,500 per day
Output	Typically between 90 and 110 m^3 of concrete per day
Concrete (supply only)	Between £80 and £90 per m^3
Steel	Approximately £1,000 per tonne

Table 4.1.2 - General data for untensioned corrugated beam

Untensioned corrugated beam	
Single rail	Between £20 and £25 per metre
Double rail	Between £40 and £45 per metre
Posts	Between £20 and £25 each
Socketed foundation	Approximately £25 per post

4.2 Summary

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 this report are 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. Steel barriers are assumed to have either driven posts or socketed concrete foundations. Socketed post foundation provides for easier replacement of the barrier following damage.

A summary of the basic costs for the barrier systems considered in this study is provided in table 4.2 below:

Table 4.2: Summary of basic costs for barrier systems

Barrier system	Performance	Basic cost per linear metre. Average ± 10%
Standard profile surface mounted concrete step barrier (figure 3.1)	H2 W2 Higher containment	£55
Untensioned double-sided corrugated beam, in socketed foundations (figure 3.2)	N2 W3 or W4 Normal containment (posts 4m centres)	£51
Untensioned double-sided corrugated beam, with driven post foundations (figure 3.3)	N2 W3 or W4 Normal containment (posts 4m centres)	£45
Untensioned two-rail single-sided corrugated beam, in socketed foundations, 2 No. barriers, hard central reserve	H2 W4 or W5 Higher containment (posts 2m centres)	£126 (2 No. barriers at £63/m)
Untensioned two-rail single-sided corrugated beam, with driven post foundations, 2 No. barriers, soft central reserve	H2 W4 or W5 Higher containment (posts 2m centres)	£100 (2 No. barriers at £50/m)

These rates show that the cost of using a steel barrier system to provide higher containment in the central reserve equivalent to CSB would be prohibitive.

However, most previous cost comparisons have been made between higher containment CSB and the lower performance N2 steel systems. The figures above show that reducing the containment performance level from H2 (CSB) to N2 (steel) would achieve a 7 per cent to 18 per cent saving on the first cost of the barrier system. This cost difference will offset by the reduced maintenance and repair requirements of CSB and longer design life compared to steel systems. Whole life issues are discussed in Section 5.

It must be remembered that if post spacings on steel barriers are less than 4 metres, the above costs for the steel barriers would be increased. This increase is 14 per cent for a reduction to 2.4 metre centres for socketed foundations and 7 per cent for driven posts. If the post spacing is reduced below 2.4 metres then a further 7 per cent increase should be applied to the costs.

5 WHOLE LIFE COSTS AND SUSTAINABILITY ISSUES

This costing analysis has not addressed whole life costs or comparative sustainability of different barrier systems. However, in order to understand the difference in performance between barrier systems it is necessary to consider the requirements for routine and emergency maintenance and repair over the lifetime of the road network.

5.1 The site

Historically steel barrier systems required routine maintenance in order to retension the system. This is true of many steel barriers currently in use in motorway and truck road central reserve. However, accounts vary as to how much of this routine retensioning work is actually carried out on the network. The new generation of untensioned corrugated beam barriers do not require this kind of routine maintenance.

Steel barriers have a typical design life of 25 years, quoted in the TRL whole life analysis for the M25 [2].

Concrete step barrier requires no routine maintenance and has a typical design life of 50 years. This will result in reduced maintenance costs. Also the reduced number of interventions required by the maintenance work force reduces the risk of exposure of the work force to accident or injury, hence providing safety benefits to the work force.

5.2 Emergency Repair

Deformable barrier systems are designed to deform under impact. This means that following any impact, a deformable system will require emergency repair. The untensioned steel barrier systems costed in this report will therefore require emergency repair, throughout their lifetime.

Considering the N2 barrier system, although this is tested to EN1317 providing containment for a 1.5t vehicle, lesser impacts from smaller vehicles will still damage the barrier system and compromise its future containment performance such that a section of the barrier and posts would need replacing. The same is true for the higher containment deformable systems.

By contrast, the surface mounted CSB does not deform under impact and does not require repair, following the EN1317 test for H2 containment. Even after impact, the barrier continues to provide H2 level containment. Surface mounted CSB would therefore only require emergency repair in case of a major impact, significantly above the performance level to which it is tested. Benefits in reduced emergency repair can be realised as well as reducing the exposure to accident or injury whilst working in the central reserve.

This is illustrated by the Transport Research Laboratory whole life analysis carried out for the M25, which quotes figures for repair of central reserve barriers. This reported that between 1st January and 31st December 2002 there were 36 No. reported incidents against the concrete central reserve barrier, of which none required any remedial works or repairs. This compares to 784 No. reported incidents with the steel barrier, for which all required repair. (Concrete barrier comprises 12.7 per cent of the length of central reserve considered in that study).

5.3 Consequential impacts

The sustainability of a barrier system is a function of not only the embodied energy in the construction of the system and its maintenance, but also of wider consequential impacts that arise from human impacts (injuries and loss of life), pollution from traffic congestion during maintenance works, economic effects from traffic congestion, etc. The issues are many, complex and interrelated. It is recommended that investigation of these impacts should form a separate study.

[2] Williams, G. L., Whole Life Cost-Benefit Analysis for Median Safety Barriers PR/SE/903/04 HA Task Ref No. 3/372/R22.

6 CONCLUSIONS

This study has derived basic comparative costs for three central reserve barrier systems, installed on a like-for-like basis, given the difference in performance levels provided. The three barrier systems considered were:

- Surface mounted concrete step barrier H2 W2.
- Untensioned double-sided corrugated beam N2 W3 or W4.
- Untensioned single-sided corrugated beam H2 W4 or W5.

All concrete step barriers costed in this study are surface mounted barriers conforming to the Britpave specification. Steel barriers have been costed with socketed concrete foundations. This foundation type provides for easier replacement of the barrier following damage.

The cost of steel barriers with driven post foundations have also been included.

For the purposes of the cost comparison the site was assumed to have the following features:

- 5 km of rural motorway.
- 4.5 metre wide central reserve.
- Hard and soft central reserve details.
- Balanced carriageway on embankment.
- No lighting columns in central reserve.

Basic comparative costs for the barrier systems per linear metre were derived using data obtained from industry. In summary these costs are:

Barrier system	Performance	Basic cost per linear metre. Average ± 10%
Standard profile surface mounted concrete step barrier (figure 3.1)	H2 W2 Higher containment	£55
Untensioned double-sided corrugated beam, in socketed foundations (figure 3.2)	N2 W3 or W4 Normal containment (posts 4m centres)	£51
Untensioned double-sided corrugated beam, with driven post foundations (figure 3.3)	N2 W3 or W4 Normal containment (posts 4m centres)	£45
Untensioned two-rail single-sided corrugated beam, in socketed foundations, 2 No. barriers, hard central reserve	H2 W4 or W5 Higher containment (posts 2m centres)	£126 (2 No. barriers at £63/m)
Untensioned two-rail single-sided corrugated beam, with driven post foundations, 2 No. barriers, soft central reserve	H2 W4 or W5 Higher containment (posts 2m centres)	£100 (2 No. barriers at £50/m)

This study has shown that provision of continuous H2 containment using deformable steel systems would be prohibitively expensive. However, H2 W2 surface mounted CSB may be provided for a cost comparable to the N2 W3 or W4 deformable systems, which offer inferior containment and working width performance.

If the post spacing for steel barriers is less than 4 metres, the above costs for the steel barriers would be increased. This increase is 14 per cent for 2.4 metre centres with socketed foundations and 7 per cent for driven posts. If the post spacing is reduced below 2.4 metres then a further 7 per cent increase should be applied to the costs.

The costs used in this report are supplier costs for installation of the barrier system by a specialist installer.

It is apparent that when considering whole life cost the concrete step barrier has advantages over any steel barrier option. The design life of the concrete step barrier is double that of steel equivalents and does not require routine maintenance. Any impact on a steel barrier requires remedial attention, with impacted steel barrier requiring replacement. A significant impact on concrete step barrier needs to occur before repair is required. The concrete step barrier can be left unattended following an impact up to and equivalent to BS EN 1317 TB51 test, and will continue to provide the H2 containment performance. The net result is that significantly fewer interventions by the maintaining highway labour team are required during the life of a concrete step barrier, compared to a deformable steel barrier. This significantly reduces the exposure of the work force to risk of accident and injury during maintenance or repair of the barrier.

13 Conclusions

Clearly the basic cost of the barrier system only represents one aspect of the costs associated with installing barrier in a central reserve. It is intended that a further study will be undertaken to examine the influence on costs of items such as:

- Drainage.
- Lighting columns.
- Central reserve surface treatment.
- Transition and terminal units.
- Bifurcations, tapers and interface with structures.
- Level difference across central reserve.

Further studies will also address the impact on construction programme, given the higher output of CSB compared to steel systems. The potential cost savings from reduced land take and cross section by, for example, reducing central reserve width from 4.5 metres to 3.5 metres using CSB will also be investigated.

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The British In-situ Concrete Paving Association

BP/37 CONCRETE STEP BARRIER STUDIES
Barrier cost comparison Stage 1 of 3

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