



A model set of asphalt sustainability indicators

**Prepared for Highways Agency, Quarry Products Association,
and Refined Bitumen Association**

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Executive Summary

This report recommends a 'model' set of indicators that could be adopted and developed by the asphalt industry, should it wish to take further steps towards the measurement and reporting of its progress towards greater sustainability. The report provides an overview of sustainability and the potential role of sustainability indicators and reporting in the asphalt industry's response to Government sustainable construction policy. The work undertaken in developing the model set of indicators is a result of collaboration between Quarry Products Association, Refined Bitumen Association and Highways Agency.

Areas of more-sustainable practice already exist within the asphalt industry, including durable, long-life products, environmental management, recycling and recyclability. Some companies have been using indicators and providing environmental or sustainability reports for a number of years.

Pressure exists for the industry to do more, by way of Government policy, client procurement and expectations amongst other stakeholders including shareholders and the public. One important element of improving and reporting the economic, environmental and social performance of the industry is the use of indicators. A set of Key Performance Indicators (KPIs) has therefore been recommended. They are largely based on the set reported by the Construction Products Association. Most of the KPIs could readily be adopted by the asphalt industry and in some cases are already measured by some companies. Other indicators will require a degree of development. There is also an important role for reporting and representation of the industry at the sector level.

To decide when the time is right to launch this indicator set and in what form, it will be important for the industry to consider a number of issues. These include the level of acceptance of the need for sustainability management and reporting both at the company and sector level; the need for common KPIs for the industry and if the recommended set are appropriate; and the willingness for public reporting. When these issues have been agreed an appropriate method for promoting the indicators can be implemented.

1 Introduction

This document has been produced by TRL as a result of collaboration between Quarry Products Association (QPA), Refined Bitumen Association (RBA) and Highways Agency (HA). Its purpose is to present the asphalt industry with an overview of sustainability and the potential role of sustainability indicators and sustainability reporting in the industry's response to Government sustainable construction policy.

Specifically, this document contains a list of indicators produced as a 'model' set, which could serve as an example and be developed and adopted by the industry should it wish to take further steps towards the measurement and reporting of its progress towards sustainability. The potential benefits of adopting a common set of indicators are described.

Asphalt companies are currently at different levels of engagement with sustainability policy, practice and reporting. The recommendations of this report have, therefore, been made sufficiently flexible to enable companies to consider them at the level appropriate to them.

This document could be used in several ways, it could:

- 1 Form the basis of an internal discussion document to help industry decide on its future strategy in this area, either at a company or a sector level.
- 2 Be published for a wider audience to demonstrate progress so far and encourage a broader discussion within the industry and other interested parties.
- 3 Form the basis of an industry consultation, the response to which will help to shape how the asphalt industry tackles the issue of sustainability.
- 4 Form the basis of a wider consultation, which would be used to influence how the industry is perceived amongst its customers, other decision makers, shareholders and the wider public.

2 Sustainability and the asphalt industry

2.1 What is sustainability?

Sustainability has been defined in many ways but amongst the simplest and best known is the Brundtland definition (WCED, 1987):

'Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.'

Any industry, including those in the construction sector, who's business is based upon the use of finite natural resources could be considered unsustainable in the long-term. In 2001, the construction industry in the UK used over 400 million tonnes of materials, including about 26.5 million tonnes of asphalt.

However, the critical need for a built environment means that, without a radical change in the way we do business and live our lives, continued economic growth and social progress would be impossible without construction. It is the achievement of these shorter-term goals which drives the industry. Furthermore, the immediate impacts of construction on the environment and

society are those which define the industry's current operation and development.

Government sustainable development strategy defines four central aims (DETR, 1999):

- stable levels of economic growth and employment;
- social progress for all;
- protection of the environment;
- prudent use of natural resources;

and recognises the need to integrate these aims and evolve sustainable development policy (DEFRA, 2005).

The move to greater sustainability might be considered to mean finding the solutions to long-term problems while improving performance in terms of immediate issues. It is important to acknowledge that the use of finite resources cannot continue indefinitely and that they should be used more efficiently. It is equally important to address the immediate contributions and impacts of the industry on the environment and society.

Recycling is one area where the asphalt industry has great potential for making an impact on sustainability and has made significant progress. Although no figures are available for the UK, the European Asphalt Pavement Association has firmly asserted that (EAPA 2004):

'If reclaimed asphalt is recovered and free of contamination, it can be guaranteed that the total amount of this reclaimed asphalt can be reused as construction material.'

In addition, in England in 2001 about 2.5 million tonnes of secondary and recycled aggregates were used in asphalt and there is some capacity for this figure to rise (ODPM, 2002a, 2002b).

2.2 What does sustainability mean for asphalt producers?

In translating its sustainable development policy into a policy for sustainable construction the Government defined ten themes for action (DETR, 2000):

- Re-use of built assets (and recycling).
- Do not pollute.
- Minimise waste.
- Biodiversity.
- Efficient construction.
- Conserve water.
- Energy consumed during construction.
- Energy during use.
- Respect for people.
- Setting targets.

It is clear from the increasing number of environment and sustainability reports produced by asphalt companies that they can have a significant impact in most, if not all, of these areas. Many companies now produce and publish plans for more recycling; waste, energy and water management; health and safety improvements; accredited environmental management; and staff skills training.

2.2.1 Environmental management

One area of good practice within the asphalt industry is in the adoption of environmental management systems

(EMS). As part of this work TRL undertook a survey of the uptake of EMS and environmental reporting in seven asphalt companies. The companies ranged in size from the operator of a single asphalt plant to one with 69 sites. The survey results showed that:

- Five of the companies had ISO14001 accredited EMS at all sites. The remaining two had introduced this at some sites.
- Two of the companies had first introduced an EMS in 1994.
- All of the companies had an Environmental Policy and three of these had been operational for over five years.
- One company had published an Environmental Report for eight years.
- Six of the companies produced an Environmental Report and four monitored performance against environmental indicators.

2.2.2 Long-life roads

In response to the increasing demands of its customers and of road users, the asphalt industry is developing a range of new, improved products. These products include a wider range of recycled materials, reduce traffic noise and will last longer under growing traffic levels.

Until recently, roads were simply built thicker in order to cope with increasing traffic levels. These road pavements were designed to have a finite initial life (and are known as determinate life pavements, DLP). They required periodic reconstruction to maintain them in a serviceable condition.

With the advent of stiffer asphalt materials, improved design guidance and new condition monitoring techniques, it has been possible to create long-life road pavements (LLP) (Nunn *et al.*, 1997). These roads need to be constructed from high quality materials but require less asphalt over the lifetime of the road because only the thin surface layer at the top, which is in contact with vehicle tyres, needs to be replaced every ten years or so. The rest of the road structure should remain intact for a very long time. The latest research has resulted in guidance on how, most cost effectively, to upgrade existing roads to this long-life condition by adding to or replacing older material (Merrill, 2005).

Making roads more durable results in improved 'resource efficiency' and will reduce road works and the associated traffic jams while also reducing the environmental impacts caused by making and transporting asphalt. These impacts have been estimated using a Life Cycle Inventory (LCI) model that was specifically produced for the asphalt industry (Stripple, 2000).

To compare the impacts of a DLP and LLP, a construction and maintenance programme over 40 years has been projected for each. For the DLP this assumed a 250mm thick construction, periodic surface maintenance and a scheduled reconstruction at about 20 years. The LLP is constructed to 300mm thickness but does not require reconstruction. Next, the Highways Agency's programme for the calculation of the whole-life costs of road schemes



Figure 1 Long-life asphalt roads cope with higher traffic levels

(Highways Agency, 2004) was used to estimate the duration of roadworks and associated road user delay costs for both roads. The LCI model was used to predict the energy consumption needed to construct and maintain each road.

The results of these analyses show that, compared to the DLP, the long-life road:

- Consumes about 10% less resources in terms of aggregate and bitumen.
- Therefore results in about 10% less energy consumption and associated emissions and reduction in transport movements.
- Over the lifetime of the road, reduces traffic management costs by about 5%, reduces road closures by about 15% and delay costs by nearly 25%.

2.3 Opportunities at the sector level

While it is important for individual companies to manage their performance with respect to sustainability, there is also a role for the asphalt industry as a whole. The performance of the industry as a sector will have more impact on some parties than that of individual companies, for instance on policy makers, regulatory bodies and in public opinion. Some decisions which have an important impact on all asphalt producers are based upon the image of the whole industry. As Alistair Darling, then Secretary of State for Transport, said at the Freight Transport Association annual dinner in October 2004:

'... people are rightly becoming more and more concerned about the environmental impact of transport.'

Public opposition and road building's lack of voter appeal have also been blamed for Government's failure to deliver major transport projects by then Transport Minister Kim Howells, at the Freight Transport Association's Freight Summit in February 2004:

'Roads are a most contentious issue. They are the best way of using the money available, but it is not politically correct to say so.'

A number of trade organisations in the construction sector are following guidance produced by the Sustainable Development Commission (2002a) in developing sector sustainability strategies. These include the British Cement Association, Construction Products Association, Steel Construction Sector and UK Forest Products Association amongst many others. During the production of this report the Quarry Products Association has published a document that sets out the key stages in the evolution of a sustainability strategy for its members (QPA, 2005).

Sector trade associations can represent business to policy makers and help to enhance the reputation of an industry. They can also help member companies compare their performance and become more competitive but to do this effectively there needs to be an agreed sector strategy.

Most asphalt production forms part of a larger business with other interests, most commonly quarrying and cement or concrete production. The major players are generally part of multinational companies with their own company sustainability strategies. To provide information and develop sector level plans for asphalt operations will, therefore, require a degree of disaggregation of measurements.

2.4 What is a sustainable industry?

Customers satisfied with the products sold to them and shareholders satisfied with the value of the business are obvious and crucial elements of a successful industry now and for the future. Beyond this, there are company behaviours that demonstrate that the right balance is being struck between financial performance and social and environmental issues. Some of those suggested by the Sustainable Development Commission (2002b) are:

- Investment in new plant and R&D.
- Involvement in community projects.
- Local sourcing.
- Pay and working hours.
- Health and safety.
- Emissions and waste plans.
- Customer satisfaction surveys.
- Company and sector sustainability plans.
- Training.
- Indicators.

Some of these issues are very specific to individual producers, such as investment in plant but others can be more significant if co-ordinated at sector level in addition or instead, such as R&D and Training. Perhaps the most important step is to develop sustainability plans to act as the driver for improved performance.

A powerful driver for any sector is to meet the requirements of its clients. In interviews, procurement managers in highway authorities, when asked how asphalt suppliers could demonstrate quality, commonly raised the following items:

- Recycling.
- Waste.
- Whole life costs.
- Partnering.
- Training.
- Health and safety.
- Profitability.
- Performance and improvement indicators.

A clear indication that a successful business is about more than products or services sold has recently arrived in the form of the Highways Agency's Capability Assessment Toolkit. This requires HA's contractors to declare their performance in a range of areas related to business organisation and operations. A set of 18 indicators are self-scored and audited, in six areas:

- Direction and leadership.
- Strategy and planning.
- People.
- Partnering.
- Processes.
- Internal resources.



Figure 2 Highways Agency's CAT assesses its contractors over a range of capabilities

The toolkit was not explicitly designed to measure sustainability performance but many of the themes are common to those recommended for business sustainability plans. This is no coincidence because in identifying those attributes displayed by companies most likely to provide quality and value, HA have also identified those which will make a business thrive, now and in the future.

3 Measuring sustainability

3.1 Why measure?

To monitor performance and plan for improvements indicators need to be selected and a measurement system developed. Having a set of indicators to provide evidence of performance can have a number of uses including:

- Performance planning.
- Providing evidence for quality submissions in tendering.
- Reporting to shareholders and other investors.
- Reporting to planning authorities, regulatory bodies and the public.

Some of these functions may be internal or confidential but open reporting and publication of performance has now become mainstream.

In February 2004 the Co-operative Bank was named as the UK company that had produced the best sustainability report in the last year as part of the Association of Certified Chartered Accountants (ACCA) awards. Shell International was runner-up. Executive Director of ACCA UK said:

'ACCA is pleased to have received so many strong entries for this year's UK Awards which recognise that sustainability reporting helps all stakeholders to gauge non-financial performance.'

A number of asphalt producers are already producing sustainability reports and examples of these and the indicators they use are:

- Tarmac 2002:
 - Health and Safety; Target for 2005: Zero lost time injury accident rate.
 - Energy Consumption; 92.0 kWh (specific energy consumption) per unit production with a target to reduce this to 88.4 within eight years.
- Aggregate Industries 2000:
 - Water consumption; 112 thousand m³ compared with 215 in 1999.
- RMC 2001 (including aggregate, asphalt, cement and concrete production):
 - Emissions of CO₂; 47kg per tonne of product produced and transported with a target reduction of 1% per year.
 - Generation of waste; 14kg per tonne of product produced and transported with a target to reduce by 1% per annum.

3.2 Why benchmark?

Some of the major benefits to be gained from performance measurement and reporting can only be delivered effectively at the sector level. These benefits include the representation of the industry to policy makers and regulators.

A further important benefit of sector level reporting is the potential to compare performance between companies. By comparing company performance against a sector benchmark, for instance an average performance level within the industry or a mutually agreed best practice level, then an individual company can make better estimates of how its performance should be considered and where improvements should be targeted.

However, to establish sector level performance measurements and a benchmark, a common set of indicators needs to be established. Consultation with some members of QPA and RBA and with HA R&D officers has led to the development of a set of indicators with the objective of providing a 'model' set, considered to be broadly acceptable to the asphalt industry. The specific indicators and how they were developed is described below.

4 What to measure

4.1 Sustainability impacts

Before deciding on what indicators of sustainability should be chosen it was important first to review the major impacts on the asphalt industry in terms of the sustainability themes listed in Section 2.2. This was done in workshops with members of QPA and RBA and with HA staff responsible for delivery of construction and maintenance programmes. The results were reviewed by a steering committee formed from QPA and RBA members, HA R&D officers and a TRL project team. A consensus was formed around six key Impact Areas:

- 1 Specification of Materials; including specification and resource efficiency in terms of durability and use of recycling and alternative aggregates.
- 2 Specification of Plant and Equipment; including the performance of the latest paving technology.
- 3 Maintenance Intervention; in terms of intervention standards and service levels.
- 4 Health and Safety and Training; which is an area where major improvements are already underway within the construction industry.
- 5 Procurement; reviewing latest developments on customer's expectations of asphalt producers.
- 6 Environmental Management; including environmental management systems (EMS) and environmental statements.

A review of other, existing indicator sets was also made.

4.2 'Model' indicator set

After a review of the various indicator sets that had been adopted by the construction industry within the context of the six areas described above, a list of potential indicators was drawn up. It was not possible to recommend indicators in all of these areas. However, a broad coverage of the impacts of the industry in terms of economic, social and environmental issues (including resource use) was achieved. Two sets of indicators are recommended; 1. Key Performance Indicators (KPIs) and; 2. Possible Impact Area internal Diagnostic Indicators.

1. Key Performance Indicators

The KPIs are designed to benchmark the industry as a whole and within the construction products sector, and to be suitable for public reporting as well as internal performance management. KPIs are framed in such a way that they can provide information at a general level and be easily understood by a broad range of stakeholders, not necessarily with a detailed knowledge of the industry. Because the KPIs can cover a range of information, for instance total fuel consumption, a set of Measurement Diagnostics is needed to provide the information to generate the KPI value and to give the extra level of detail needed to understand and manage the impacts (e.g. fuel consumption broken down by fuel type).

The KPIs (see Table 1) largely coincide with indicators in the Construction Products Association (CPA) set (Construction Products Association, 2004), which are currently being used to monitor the performance of the wider construction products sector. These have been developed in line with the accepted model for sector sustainability strategies (Sustainable Development Commission, 2002a). The CPA indicators come with a prepared customer satisfaction questionnaire to provide comparable results. Using CPA indicators will allow a wider comparison of the asphalt industry compared to other sectors. Some of the CPA indicators are not as relevant to the asphalt industry as to the manufacture of other products and have not been recommended, for instance ‘packaging management’. Some of the indicator values are generated from information that is required legally, such as reportable accident rates. Others require information that most asphalt companies will hold in some form, such as fuel and electricity consumption. Some indicators require data that are less likely to be recorded currently. Individual companies will, therefore, need to decide their own priorities, current capabilities and aspirations in deciding the timetable for adopting the indicators.

As an example of current practice, a review of measurements made at 15 of Tarmac’s stand-alone asphalt plants revealed that data for nine of the environmental and social KPIs are already measured.

2. Impact Area Diagnostic Indicators

The Impact Area Diagnostic Indicators would form part of best practice management and potentially, specific reports for clients. The Impact Area Diagnostic Indicators cover additional areas of high impact on the sustainability of the industry but which may not be suitable for publication in the same way as a KPI for reasons of confidentiality or complexity (see Table 2).

4.3 What to do with the results

Of course, it is not sufficient simply to make measurements. To make progress, a performance improvement cycle needs to be established based upon indicator measurements and actions to improve performance. This would enable both the industry and individual companies to regularly report on its progress towards improved sustainability. The improvement cycle would be composed of the following elements:

- An Improvement Plan and cross-reference to corporate strategy in other areas.
- Targets for improvement.
- Measurements of performance against indicators.
- Benchmarking at company and sector level.
- Performance reporting.
- A revised Improvement Plan.

Table 1 Asphalt sustainability Key Performance Indicators

<i>KPI</i>	<i>Measurement diagnostics</i>
Environment	
1 Energy consumption (in production of asphalt) per tonne of production. ²	Tonnes of asphalt produced. ² Energy consumption: • Electricity. • Natural gas. • Gas oil. • Fuel oil. • Others.
2 Transport movements of asphalt per tonne of production.	Outward movements: • Road. • Water. • Rail.
3 Secondary and recycled material used in production (expressed as a percentage of total production).	Recycled asphalt (not including planings). Secondary materials: • Glass. • Foundry sand. • Steel slag. • Asphalt planings. • Blast furnace slag. • Other.
4 Durability.	See Impact Area Diagnostic Indicators.
5 Site operating under EMS.	ISO14001.
6 Waste produced per tonne of production.	Tonnes of inert waste. Tonnes of hazardous waste.
Social	
7 Number of complaints received.	Number received at production site. Number responded to in 4 weeks.
8 Safety (number of RIDDOR injuries) per number of full time employees. ³	Asphalt plant. Contracting.
9 Training days per number of full time employees.	
10 Sick absence per number of full time employees.	
11 Qualifications.	NVQ or higher.
Economic	
12 Client satisfaction (see Construction Products Association, 2004, for questionnaire).	Performance • Quality. • After sales advice. • Delivery. • Value for money. • Sales advice.

¹ Expressed as kg CO₂ (see Construction Products Association 2004 for conversion factors).

² This value is needed to normalise KPIs 1, 2, 3 and 6.

³ Regular workforce on full time or equivalent part time basis to normalise KPIs 8, 9 and 10.

Table 2 Possible Impact Area Diagnostic Indicators

<i>Indicator</i>	<i>Comment</i>
Area 1: Specification of materials	
1 Durability.	This indicator will require the results of a number of physical tests to be combined as a durability rating. Suitability of tests is under discussion. The tests could also form part of a specification procedure.
Area 2: Specification of plant and equipment	
2 Surface coarse evenness.	Fuel consumption and transport movements are already included in the KPIs. Other aspects of performance are already specified (e.g. asphalt temperature, compaction, pavement evenness). This area may result in Case Study / Best Practice guidance, which could possibly lead to further diagnostic indicators. The issue of workmanship is also covered under training. Evenness is chosen as the Indicator because it is probably the best single measurement of quality and is important to road users.
Area 3: Health and safety and training	
3 Percentage employees with CSCS cards.	This specific qualification should be included as an additional indicator. Issues of workmanship need to be considered but it is not clear how this can be measured.
Area 4: Maintenance intervention	
	This area may already be adequately covered by the KPIs.
Area 5: Procurement	
4 Company profitability. 5 Company productivity. 6 Percentage work undertaken (or subcontracted) under preferred supplier basis.	Indicators 4 and 5 are Construction Best Practice Programme indicators and are benchmarked for industry. It is currently suggested that the asphalt industry may not wish to accept these as KPIs (and they are not in the CPA set) but they are nonetheless important factors and their status should be considered. Indicator 6 reflects the move to partnering within the construction sector.
Area 6: Environmental management	
	Indicators are covered by Environmental KPIs. Further issues in this area include the potential development of Environmental Product Declarations for asphalt.

5 Next steps

A purpose of this paper is to consult and prompt discussion within the asphalt industry on the acceptability of the ‘model’ indicator set and to determine the level of commitment that may be expected to using the indicators, should they be launched in the industry. Discussions should include asphalt producers, contractors and clients as well as members of other stakeholder groups, such as plant operators, environmental groups and training organisations.

An attempt has been made below to summarise some of the benefits and potential disbenefits of adopting the indicators.

On balance, future policy drivers will make the benefits necessities rather than options, while the commitments and resources identified as disbenefits are likely to become unavoidable. The introduction and monitoring of sustainability KPIs will also become unavoidable for much of the asphalt industry.

In order to decide if the time is right to launch this ‘model’ indicator set, and in what form, it will be important for the industry to consider the following questions:

- Does the asphalt industry accept the need to measure and manage sustainability at company level and at a sector level?

<i>Benefits</i>	<i>Potential disbenefits</i>
Demonstrates a commitment to improved sustainability within the asphalt industry.	Raises expectations within stakeholders and other groups which may not be realistic.
Provides the basis for a sustainability strategy at company and sector level.	May require a commitment the industry is not ready to make.
Records performance to manage the improvement cycle.	Requires resources to support a measurement system.
Identifies aspects of business performance associated with non-financial risks.	Requires resources to manage impacts other than financial performance.
Demonstrates and reports performance to clients, decision makers and other stakeholders.	Provides a level of openness that may be used as a basis of criticism from some groups.

- Should the role of asphalt producers include developing and reporting against indicator sets at the company and sector level?
- Is it right to develop a single set of indicators for all asphalt companies to use?

- Is it possible for asphalt producers, where this is only a part of a wider business, to disaggregate measurements of performance associated with asphalt?
- Are the recommended indicators suitable?
- Would the industry be willing to adopt the ‘model’ indicators and measure performance against some or all of them?
- Would it be willing to report performance against the KPIs publicly?
- Would it be willing to provide data to establish industry benchmarks at a sector level (perhaps anonymously)?

The answers to these questions will help decide which actions to take next.

6 Acknowledgements

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Abstract

This report has been produced by TRL as a result of collaboration between the Quarry Products Association, Refined Bitumen Association and Highways Agency. Its purpose is to present the asphalt industry with an overview of sustainability and the potential role of sustainability indicators and reporting, in the industry's response to Government sustainable construction policy.

Areas of increasing sustainability already exist within the asphalt industry, including durable long-life products, environmental management, recycling and recyclability. Some companies have been using indicators and providing environmental or sustainability reports for a number of years.

Government policy, client procurement and expectations amongst other stakeholders, including shareholders and the public, are generating pressure for the industry to do more. Indicators are needed to monitor and report performance and plan for improvements. Before deciding which indicators should be chosen, a review of the major sustainability impacts of the asphalt industry was made, in workshops with members of QPA, RBA and HA.

A 'model' set of Key Performance Indicators has been recommended that could be adopted and developed by the asphalt industry, should it wish to take further steps towards the measurement and reporting of its progress towards greater sustainability. They are largely based on the set reported by the Construction Products Association. There is also an important role for reporting and representation of the industry at the sector level.

To decide when the time is right to launch this indicator set and in what form, it will be important for the industry to consider a number of issues. These include; the level of acceptance of the need for sustainability management and reporting both at the company and sector level; the need for common KPIs for the industry and if the recommended set are appropriate; and the willingness for public reporting. When these issues have been agreed an appropriate method for promoting the indicators can be implemented.

Related publications

TRL639 *Guidance on the development, assessment and maintenance of long-life flexible pavements* by D Merrill. (In production)

TRL636 *The application of Enrobé à Module Élevé in flexible pavements* by P J Sanders and M Nunn. 2005 (price £40, Code HX)

TRL 611 *A guide to the use and specification of cold recycled materials for the maintenance of road pavements* by D Merrill, M Nunn and I Carswell. 2004 (price £40, code HX)

TRL598 *Development of new materials for secondary and recycled aggregates in highway infrastructure* by K E Hassan, L Elghali and C R Sowerby. 2004 (price £40, code HX)

TRL591 *The use of asphalt arisings as Type 4 sub-base* by D P Steele, D J MacNeil and V Atkinson. 2004 (price £40, code HX)

TRL566 *Basic Oxygen Steel slag as surface course aggregate: an investigation of skid resistance* by P G Roe. 2003 (price £30, code EX)

TRL250 *Design of long-life flexible pavements for heavy traffic* by M E Nunn, A Brown, D Weston and J C Nicholls. 1997 (price £35, code H)

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