Introduction

The goodquarry.com website section on Quarry Fines and Waste has been extensively revised and updated. Quarry fines and wastes are a largely unavoidable by-product of the extraction and processing of aggregates. They form a significant proportion of current quarry output. (see table below). They are defined as wastes because no market currently exists for them, but unlike many other wastes they are generally inert and non-hazardous. Materials that may be classified as quarry wastes include overburden (although this is frequently used in restoration) and interburden (material of limited value that occurs above or between layers of economic aggregate material) and processing wastes (non-marketable, mostly fine-grained material from crushing and other processing activities.)

Good practice calls for the minimisation of waste and fines production, although recent legislation has conflicted with this aim. Operators should also develop methods for the mitigation of any adverse effects on the environment and local communities by screening and careful management of waste production, movement and final use.

Summary

goodquarry.com contains much useful information for both operators and mineral planning authorities on the subject of quarry fines and waste which is summarised below.

Mineral Planning Authorities

Good practice means that MPAs should consider the need to agree or specify planning conditions relating to:

- The location of waste heaps
- Controlling of leachate and run-off
- The height and shape of waste heaps
- Surface treatment, e.g. vegetation
- Progressive restoration
- The duration of temporary heaps.

Operators

Good practice means that operators should try to:

- Minimise the production of waste
- Find a use for waste, e.g. landscaping
- Site waste heaps within workings
- Use waste for progressive restoration
- Site waste heaps having regard to potential effects upon:
  - The landscape
  - Groundwater
  - Surface watercourses
  - The flood regime.

- Encase contaminated waste so that it cannot escape. Store top- and sub-soil and overburden with a view to ultimate restoration.
- Use wastes positively. If they cannot be hidden then they should be landscaped and vegetated as soon as possible.

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Further Information

www.goodquarry.com
www.mineralsuk.com
www.bgs.ac.uk

Estimated production of aggregate, quarry waste and quarry fines in the UK

<table>
<thead>
<tr>
<th>Rock type</th>
<th>Saleable aggregate</th>
<th>Quarry waste</th>
<th>Quarry fines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandstone</td>
<td>10.0</td>
<td>1.1</td>
<td>3.3</td>
</tr>
<tr>
<td>Limestone</td>
<td>67.3</td>
<td>7.5</td>
<td>18.8</td>
</tr>
<tr>
<td>Igneous and Metamorphic Rock</td>
<td>44.6</td>
<td>5.0</td>
<td>11.2</td>
</tr>
<tr>
<td>Sand and Gravel</td>
<td>82.4</td>
<td>9.2</td>
<td>20.6</td>
</tr>
<tr>
<td>Total</td>
<td>204.3</td>
<td>22.8</td>
<td>53.9</td>
</tr>
</tbody>
</table>
Environmental and Social Issues

Although they are generally inert and non-hazardous, the generation, treatment and/or disposal of quarry waste and quarry fines can be a source of friction between aggregates companies, local communities and other stakeholders. This is particularly true if a site is producing more than originally planned or that can be properly accommodated within the site boundary. Therefore, ensuring that the site design is correct at the planning stage is essential.

The nature and extent of the environmental and social impacts will vary from site to site according to their characteristics and specific local context. The impacts experienced by the local community are likely to be significantly influenced by the nature and proximity of housing, amenity areas and local businesses. Different stakeholders will have quite different opinions regarding the impacts that they consider most important. Many of the potential impacts can be prevented or mitigated by the use of good practice. The acceptability of impacts that remain after good practice is applied can be assessed by their environmental and social acceptability. The acceptability of impacts that remain after good practice is applied can be assessed by their environmental and social acceptability.

The impacts that remain after good practice measures have been put in place should be considered in the context of the economic and other benefits that accrue from aggregates production.

goodquarry.com addresses and discusses all these issues.

Case studies – minimisation

Theoretical changes using industry-standard quarry management software

Case Study 1: Sandstone quarry, mid Wales producing high Polished Stone Value (PSV) roadstone and crushed rock aggregate. Replacing the secondary Horizontal Shaft Impact (HSI) crushe with a cone crushe enabled a 20% increase in production from 250 to 300 tonnes per hour and a 21% reduction in the fines content of the aggregate.

Case Study 2: Sandstone quarry, mid Wales producing high PSV roadstone and crushed rock aggregate. Replacing two secondary HSI crushe with a single secondary cone crushe gave an 8% reduction in the fines content of the crushed material.

Case Study 3: Sandstone quarry, south-west England producing high PSV roadstone and horticultural sand. A simulated process change replacing the tertiary and quaternary cone crushe with a single tertiary Vertical Shaft Impact (VSI) crushe showed that this would enable a 34% increase in the production of saleable aggregate and a 29% decrease in fines production.

Case Study 4: Limestone quarry, East Midlands producing roadstone, crushed rock aggregate and agricultural lime. Replacing the secondary HSI crushe with a cone crushe reduced the fines content of the crushed material by 34% and enabled a 50% increase in concrete aggregate production.

Case Study 5: Sand and gravel quarry, East Midlands producing ready mixed concrete, graded sand and gravel, and bagged aggregate. Increasing the size of the screen used to remove oversize (>100 mm) and replacing the VSI crushe with a cone crushe increased the production of saleable aggregate by about 9% and reduced the fines content by 55%. The proportion of material coarser than 20mm in the crushed product was also reduced by 80%.

Minimisation

The Landfill Tax and Aggregates Levy have encouraged the use of secondary and recycled materials, but also depressed the use of quarry wastes in lower value construction applications. However, quarry wastes (and quarry fines) continue to be produced and stockpiles of these sub-economic materials are increasing at some locations. Consequently, there is a developing business case for minimising quarry wastes and quarry fines generation. Business-related drivers include the need to comply with the planning process and regulation, the need to maximise revenue in the form of saleable products and the need to avoid resource sterilisation within the quarry boundary through fines disposal.

Alternatively, the need to minimise fines is driven in part by the environmental and social consequences of their production and the costs of dealing with increasing volumes. While difficult to quantify in financial terms, such consequences may represent a substantial business risk for companies, not least through damage to corporate reputation when impacts occur. Regulatory compliance is another major driver and is likely to remain so as water and air quality are highly regulated, for example.

The goodquarry.com website has a number of theoretical case studies relating to waste minimisation, as shown in the accompanying table, and also other process optimisation options and alternative uses for quarry fines.

Mitigation

A mixture of approaches is required to deal with quarry wastes; the mix being determined by what is technically and economically feasible, taking into account the concerns of local communities and other stakeholders and planning obligations.

Plan for quarry waste disposal

Disposal of quarry wastes must be carefully planned. If the design is not right, site development problems are likely to arise from waste disposal issues. Waste tips should be located to minimise potential effects on the landscape and surface water flow and quality and consider potential conflicts with local communities and stakeholders.

First beneficial use

 Quarry wastes can often be used on the site and to screen the workings. Good practice should prevent environmental and social impacts from wastes for which no beneficial uses exist. Waste tips should be revegetated as soon as possible to prevent wind and water erosion. Non-vegetated waste tips are liable to erosion and collapse. If closure tips should be regraded where necessary to create a stable final landform and to prepare them for revegetation and integration with the surrounding landscape.

Investigate alternative methodologies or technologies

The BGS carried out a series of trials of air classification to investigate the method’s potential for fines reduction as shown in the table below. This and other examples, are shown in goodquarry.com.
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Future Technology

Future developments in quarrying technology are discussed in the goodquarry.com Production and Process Technology section. They are likely to be dominated by energy and water use due to the increasing importance of climate change and the increasing cost of energy. Energy efficiency and reduction can be effected through more detailed analysis of energy usage, replacement of high energy consuming plant by newer, more efficient equipment and changes to the material handling and processing routes. Carbon offsetting of industry energy use may become more common with an increase in current tree planting schemes and calculation of carbon equivalent for each product.

Water use will involve more recycling and reuse of process water, increased capture of rainfall and investigation of additional ‘dry’ or water efficient processes to replace current ‘wet’ processes. Recycling of concrete to reuse its contained aggregates is increasing. However, the product generally has a lower compressive strength and especially drying, should be carefully and regularly examined to eliminate bad practice and encourage savings where possible. Water consumption should be monitored and, if possible, reduced by recycling, reusing and adoption of waterless fines processing. Monitoring of all stages of the process should enable bottlenecks to be identified and the comparative performance of all the separate components to be measured.

The goodquarry.com section on Production and Process Technology has a large amount of information, key findings and summaries to assist operators in improving their quarry’s performance.

Introduction

Virtually everyone connected with quarrying will know of the goodquarry.com website. It has become a well used source of information on a wide range of topical issues ranging from biodiversity to water, air pollution to planning and much more. Now there is a brand new section on Production and Process Technology, written by the British Geological Survey. It contains all kinds of useful information on crushing, screening, washing, etc. including industry case studies. It also has numerous ‘Key Findings’ which give useful information on the process under discussion. The section concludes with a summary of good practice in each of the technologies mentioned below.

Overview

The aggregates industry produces about 214 Mt per year of crushed rock and sand and gravel from over 1500 quarries throughout the UK, plus offshore dredging. Production and processing technology is a key factor in the overall operation. The four main stages in quarrying are preparation by removal of overburden, extraction, processing and finally restoration or reuse.

The methods and equipment used depend primarily on the type of deposit and the source rock being worked. The key factor is whether the material requires crushing before further processing, or just washing and separation. In all cases the overall aim is to use the minimum input (energy, water, manpower, equipment, capital etc) to produce the maximum output of saleable product with the minimum waste and environmental effect.

Extraction

Following removal of overburden by dragline or hydraulic excavator, hard rock aggregates generally require careful blasting to break the rock into small fragments (usually less than 1 m across). Excavators load haulage trucks to carry the blasted rock to the primary crusher, alternatively conveyors may be used. Sand and gravel is either worked in wet or dry conditions. Dry working is the most efficient in terms of maximising extraction and it also enables more selective extraction. Where deposits exceed 5 m, dragline excavators are extensively employed; these are robust and efficient at feeding conveyor systems. Where deposits are thinner or more consolidated, hydraulic backhoes are used. Some very unconsolidated deposits, such as dune sands or some glacial deposits may be excavated directly from the face by wheeled front-end loaders. Marine sand and gravel is worked by trail dredging where a suction pipe is pulled across the seabed at slow speed using a specialised dredger. The product, which generally has a very low fines content, is then offloaded at wharves for additional treatment before dispatch.

Crushed rock aggregate quarries tend to be larger, deeper and longer lasting than sand and gravel pits and involve large investments and outputs typically in the range 100,000 to 5 million tonnes per annum (tpa). Sand and gravel pits are usually shallower, sometimes only five or six metres deep. Operations are likely to be shorter term and typically produce 10,000 to 1 million tonnes per annum (tpa), with most in the range 100,000 – 300,000 tpa.

Panorama of limestone quarry