EXTRACTION AND USE OF BUILDING STONE: SOME SUSTAINABILITY ISSUES

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Trends

- **Before the industrial revolution much natural stone was worked and used locally as building blocks, roofing and paving;**
- **Today stone makes an important contribution to local cultural heritage – ongoing supplies are required for repair and maintenance;**
- **The development of canals and railways led to wider use of stone types and international trade expanded greatly making some types of stone regionally or globally significant;**
- **Today, competition from developing countries in Asia, Africa and South America is increasing – these have low costs despite long transport distances;**
- **This has raised some ethical supply issues.**

Economic and community benefits

- Adequate supplies of suitable stone are needed for maintenance and repair of heritage structures and building in locally compatible styles;
- Hence stone quarrying is important for communities and tourism;
- A stone industry also provides employment and income in regional areas with few other job opportunities;
- Stone quarries are often of long duration and are labour intensive therefore providing significant and steady employment;
- A stone industry supports the retention of a traditional regional skills base.

Environmental impacts

- Many stone quarries are relatively small in size and output compared with other types of quarrying
  (e.g. aggregates) therefore less heavy vehicle traffic is involved;
- Extraction is undertaken carefully to avoid damaging the stone so levels of noise and dust are often low.
- But sites may be very long-lived and affect wide areas for centuries;
- However stone, if selected carefully, is highly durable and produces no toxic by-products.

Environmental impacts

- **Because many building and roofing stone sites are relatively small scale operations these can be readily rehabilitated to improve biodiversity and geodiversity;**
- **Sites may also have industrial archaeological evidence that is worthy of preservation;**
- **Overall stone quarrying has low impact compared with most other quarrying;**
- **But few areas have been worked extensively and have given rise to major groups of quarries that are more challenging for rehabilitation and may also give rise to significant noise and dust during operations.**

Reduction of waste, reuse and recycling

- Much stone can be re-used either in the original structure or recovered for use elsewhere;
- But it is important not to stimulate damage, either commercially or through theft , to provide building materials elsewhere;
- If stone cannot be reused and is segregated from other types

  of waste it can be crushed for use as aggregate;
- In most cases less embodied energy is required compared

  with bricks, metals and plastics or recycling of other construction materials.

Resources

- Resources of some stone suitable for building stone are widespread and could be worked for many years;
- But much is localised so reserves might be worked out, or resources sterilised, by other development – it is important to safeguard potential quarry sites;
- Stone types worked in the past are still needed for repair of historic structures even though no longer quarried or mined;
- Today it is difficult to get planning permission to reopen former quarry sites because these have regenerated naturally to become nature reserves.

Transport

- Local transport is by road;
- Regional and wider distribution is often by rail or water;
- Modes of transport are similar to other minerals but quantities carried are significantly less;
- Therefore natural stone has a relative sustainability advantage in this respect;
- This talk concentrates on “cradle to gate” i.e. excluding transport and operational energy.

Energy and emissions

- Embodied energy is energy used in the manufacture of materials including extraction and processing expressed as energy use divided by product mass e.g. megajoules per kg;
- Embodied carbon expressed as kg of CO_2 per tonne of product;
- Transport energy is that used for delivery of extracted stone to the market;
- Operational energy is that used in the maintenance and service of the buildings and construction;
- These are important issues because specifiers of construction materials are increasingly calling for evidence of sustainability, in energy terms, when selecting these;
- But data compiled from a variety of sources is fairly inconsistent.

Some comparative data on embodied energy (MJ/kg)

Material	Embodied energy	Material	Embodied energy
Slate	0.1-1.0	Concrete	1.4
Sandstone	0.122-1.0	Bricks	3.0
Granite	0.1-13.9	Concrete blocks	3.5
Limestone	0.3-1.5	Plaster-board	6.8
Marble	2.0	Timber	8.5

Some comparative data on embodied CO_2 ($kgCO_2/kg$)

Material	Embodied CO2	Material	Embodied CO2
Slate	0.007-0.063	Concrete	0.100-0.107
Sandstone	0.06	Bricks	0.22-0.24
Granite	0.006-0.781	Concrete blocks	0.059-0.063
Limestone	0.017-0.105	Plaster-board	0.39
Marble	0.13	Timber	0.45-0.71

But it should be remembered that:

a) data on embodied energy of building stone is "recycled" in papers through several sources and comes from several countries where circumstances may not really be comparable;

b) this presentation draws only on English language sources;

c) sustainability is not only about CO_2 emissions and energy!

Conclusions

Stone is a non-renewable, but abundant, resource that needs to be used wisely by:

- carefully examining the economic, social and environmental costs and benefits of development now and for the future;
- identifying strategies that meet national social, economic and environmental aims well;
- safeguarding resources in the ground from other forms of development for future use.

Overall use of stone has modest environmental impacts and is essential for maintaining cultural heritage whilst resulting in real community and commercial benefits

Conclusions

- There is an increasing emphasis on demonstrating sustainability in energy terms during specification of materials;
- Data on embodied energy and carbon dioxide for stone shows reasonably good levels compared with manufactured construction materials;
- But some published results show large ranges and some materials such as concrete appear to perform as well or better;
- Ranges suggest that either site specific issues are important or that assessment methods are too variable (or both);
- More research, on a consistent basis, is needed.