Halletec Associates

Chartered Surveyors, Planning, Geological and Environmental Consultants

A Comparison of the Environmental Impact of Various Building Materials

On behalf of

Murphy Stone

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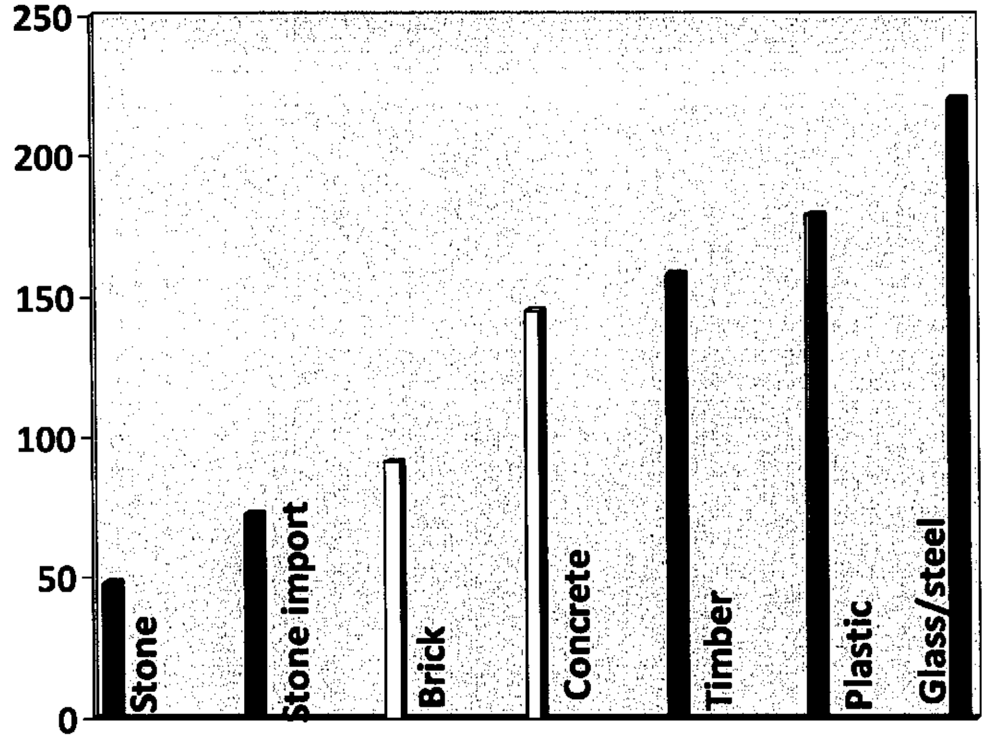
Dimension stone is widely considered to have a very small environmental impact in comparison with other construction materials due to the low rate of extraction, small scale processing and long life in service of the product. Different construction materials are known to have widely variable environmental impacts in terms of their manufacture, use in service and potential for re-use and recycling when the building reaches the end of its useable life. Many attempts have been made to quantify these impacts on a scientific basis, but the variables and the weighting attributed to their impacts are subject to debate. This report compares six different construction materials along with dimension stone imported from the Far East in an attempt to produce a simple but scientifically sound comparison.

A range of environmental impacts has been assessed for each material. Each impact has been given a weighting which is considered to be consistent with the scale of the impact, to allow comparison between the materials. A high score indicates that an impact may be environmentally more significant. For example, product life is considered to be significant as products with a short life have to be replaced more frequently and therefore re-manufactured more often than those with a long lifespan. Alternatively, production waste has a much less significant impact in terms of damage to the environment.

The six materials have then simply been ranked in order, with the lowest rank having the least impact on the environment. This ranking (red in the table below) has then been multiplied by the weighting, and the results (blue) have been totalled to give an empirical environmental impact score (green) for each material, where a high number indicates a greater impact and vice-versa. These scores are then presented in a chart for easy visual comparison.

		Building Material													
Impact	Weighting	Natural Stone		Clay Brick		Concrete products		Timber cladding		Glass/ steel		Plastic cladding		Imported Natural Stone	
Energy usage in manufacture	8	1	8	3	24	5	40	2	16	6	48	4	32	1	8
Impact of shipping to Ireland	4	1	4	2	8	1	4	2	8	5	20	1	4	6	24
Pollutants emitted in manufacture inc. raw materials	5	1	5	2	10	4	20	3	15	6	30	5	25	1	5
Waste in production	2	2	4	3	6	4	8	1	2	6	12	5	10	2	4
Impact of processing plant	2	2	4	3	6	5	10	1	2	6	12	4	8	2	2
Life of product	10	1	10	2	20	3	30	6	60	4	40	5	50	1	10
Maintenance in service	2	2	4	1	2	3	6	6	12	5	10	4	8	2	4
Overall Carbon footprint	6	1	6	2	12	3	18	5	30	6	36	4	24	2	12
Recycling potential	3	1	3	1	3	3	9	5	15	4	12	6	18	1	3
ENVIRONMENTAL IMPACT SCORE			48		91		145		158		220		179		72



Relative Environmental Impact

Summary

As the methodology used here is recognised to be subjective, it is considered essential to discuss the reasoning behind the ranking of the materials in the table. This is done for each material.

Natural Stone

This is a very small-scale extraction and processing operation. Stone is extracted by hydraulic excavator, sawing or traditional 'plug and feather' techniques, lifting with cranes or fork-lift machines, and dressing is carried out by sawing in sheds. Different stone types vary tremendously in hardness, and therefore in time and energy to cut to shape. Off-cuts can be recycled for use as aggregate, and fines from the sawing operation can be settled out and used in the restoration of the quarry. Saw sheds are generally small and hidden within the quarry. Historic buildings such as castles, churches, stately homes and civic buildings are testament to the longevity of natural stone as a building material, proving its potential to last for many hundreds of years in-situ. Upon demolition, the stone can be re-used in other buildings or crushed for use as aggregate. Maintenance in service is limited to occasional sand blasting if required, although weathering effects are often considered to enhance the aesthetic appearance of the building. The average bed height for a course of stone is much thicker than for brick, requiring over 50% less mortar for a given area of wall.

Imported Natural Stone

Large amounts of stone are imported from China, India and many other countries which compete with indigenous stone. Whilst it is true that the same environmental advantages apply in comparison with other building materials, the environmental cost of transport must also be included. This is extremely difficult to accurately assess, with many variables including road haulage distance from quarry to port, size and age of container ship and proportion of empty containers carried on the journey. It is most likely that the container would have to be off-loaded at a major port such as Felixstowe and moved to Ireland in a smaller vessel. A typical container ship will use between 40 and 70te of fuel per day and the journey would take 25 – 30 days. Thus the fuel usage would range between 1-2000te for the journey. In addition, the fuel used is very low grade and thus produces more greenhouse gases, pollution of the sea occurs and ecological damage is known to occur through transfer of species in the ballast water when it is emptied at ports far from origin. Whilst this does not equate to a major increase in carbon footprint per tonne of stone, it is none the less a significant environmental impact per trip.

Clay Brick

Brick also has a long life, with numerous buildings surviving in the UK and Ireland for over 500 years. Brick needs no maintenance in service, the effects of weathering generally being regarded as aesthetically pleasing. Energy use in production is relatively high, but some raw materials contain an element of carbonaceous material that acts as fuel, whereas others contain no natural body fuel at all and therefore use significant amounts of energy to dry and fire the ware. There is virtually no waste in production, with clay being re-used in the process and fired waste being used as aggregate, often within the quarry or even the product. The level of pollutants emitted is also highly variable, with some clays containing high levels of fluorine and sulphur whereas others contain very low levels. Brick works are generally large factories with tall chimneys and adjacent quarries. Brick can be re-used or crushed for aggregate, giving a high recycling rate.

Timber Cladding

It is considered by some that timber cladding is the most environmentally friendly building material, but this fails to take into account the negative ecological and hydrological effects of timber felling, the relatively short life of the product and the requirement for frequent treatment with chemical preservatives. The slow growth rate of trees would be a limiting factor if substantially more buildings used this material. The recycling potential at end of life is very limited. Trees also absorb carbon dioxide and emit oxygen, so the felling of woodland has a significant impact upon carbon balance in the atmosphere.

Concrete Products

This requires a three-stage process, involving quarrying and crushing aggregate, cement production and reconstituted stone/block production. The use of cement is the most environmentally damaging part of the process, requiring large amounts of energy, large and highly visible production plants (often situated in very attractive countryside) and emitting large quantities of pollutants including dust and carbon dioxide. Whilst great environmental improvements have been made by the industry in recent years, including the use of waste streams such as tyres and chemicals as fuel, its effects are still significant. The life of concrete products is expected to be less than stone or brick, although the use of concrete to make construction products in high volume is a relatively recent innovation. Recycling for aggregate is possible at end of life.

Plastic cladding

Plastic is an oil based product, and thus has a very high environmental impact through the extraction and refining of oil. Waste generated in production cannot be recycled, neither can the material itself after the building has been demolished, resulting in waste disposal to landfill. The life of such buildings is relatively short.

Glass/steel

Numerous modern buildings, especially offices and city centre type developments use these materials in great quantities. Both products require very high levels of energy in production and generate relatively high proportions of waste. High levels of pollution are produced from steel works, and the environmental impact of steel and glass production is high. With so much glass in a building, the environmental cost of cleaning is high in terms of the use and disposal of water and detergents, and at the end of life it is debateable how much of the materials can actually be segregated and recycled. Whilst this method of construction is relatively new, it is anticipated that its life will be less than other materials.