

# AGGREGATE PRODUCTION IN ICELAND

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## 1. INTRODUCTION

Iceland is a volcanic island, containing mainly basaltic rock types, and geologically it is young. The following conditions for extraction and processing of aggregates for structural purposes are exceptional in the country because of;

- a very high production of aggregates in tons per capita/year
- many small extraction sites around the country
- environmental conflicts due to extraction of rare volcanic and geological formations
- a lack of specific information regarding aggregate production volume and use
- there is no association of aggregate producers

The aggregate production has been and will long continue to be a local business based on easily accessible deposits, often local river deposits or various talus deposits in foot of cliffs. Around 90 % of the quarries are privately owned and the owners sell their products or lease the quarry to companies (contractors) which in 70–80 % cases work for the Public Roads Administration (PRA). These quarries are scattered around the country close to the roads and a total number of 3000 quarries have been registered by the PRA. Of these, only 60–70 % are in constant use. The largest aggregate producers operate in the capital region of Reykjavik and the south part of Iceland.

The main aggregate production today is from sand and gravel deposits. The abundance of these deposits varies greatly in the different parts of Iceland, but in general it can be concluded that in the most densely populated areas, much of the good quality natural sand and gravel has already been used up. In these areas, lava, scoria and pillow lava is increasingly being utilised. The total amount of aggregate resources in Iceland is not known exactly, but it can be stated that we do have large quantities of un-exploited aggregates for the generations to come. These are for example the large sandur-areas, especially in the south Iceland and bedrock and lava outcrops in other areas. Still we need much more targeted research to be carried out before any estimate on the total quantity can be made.

In general, the Icelandic aggregates that are used in roads and other constructions are of sufficient quality, as far as materials requirements are concerned. The largest concrete aggregate producer in Iceland has (sea-)dredged aggregates from the bottom of the Faxafloi bay near the capital region of Reykjavik since 1960. The material is glacio-fluvial deposits, formed at the end of the last glaciation period when the sea level was lower than present. Other producers in the capital region are producing aggregates by ripping pillow-lava and processing for further use in concrete- and roads structures.

The use of Icelandic materials for ornamental stone has been increasing for the past few years. Initially only gabbro was utilised for tombstones and to a lesser extent tiles, but now an increasing demand is also for basalt and rhyolite as claddings. These rocktypes are usually very fractured and it may be difficult to find large intact bodies of

the rock for cutting. The outcrops are scattered around the country but most of the gabbro outcrops are located in East Iceland.

At present no association of aggregate producers exists in Iceland. However, the expectation is that such an association will be initiated during this autumn (2002). Due to this situation, it is difficult to make an overview of the aggregate situation in the country.

## 2. THIS STUDY

The main purpose of this study was to establish a more accurate overview of the yearly production of aggregates in Iceland and the utilisation of the materials. In accordance to work carried out for the IAEG C-17 (International Association of Engineering Geology, Commission no. 17 on Aggregates), it was decided to conduct a survey in Iceland in order to obtain a more accurate value of produced volume of aggregate, and the quantitative utilisation of the aggregates. In an attempt to reach the correct values, various approaches were used. First a total of 19 aggregate producers were asked to fill out a questionnaire, describing their aggregate production both qualitative and quantitative for the year 2001 (see table 1). The Public Roads Administration collected information of all their materials used in the year of 2001. Additional information has also been gathered from other sources in Iceland.

**Table 1:** Questionnaire sent to Icelandic aggregate producers

### Aggregate production 2001:

Aggregate type	Fraction	Origin	Use	Volume 1000 m <sup>3</sup> /year	Method of processing
e.g. concrete sand bound aggregate.	e.g. 0-8 mm, 0-10 mm, 0-25 mm, etc.	(A) Sediment (B) Rock - (B.1) Lava - (B.2) Pillow lava - (B.3) Other (C) Pumice/ scoria (D) Other	(A) Concrete (B) Roads (B.1) Base course (B.2) Subbase (B.3) Wearing course (B.4) Gravel wearing course (B.5) Subgrade (C) Mortar aggregates (D) Landfills (F) Other (specify)		
...filled out by producer	....	....	....	....	....
....	....	....	....	....	....

## 3. RESULTS

One of the main problems while making a quantitative overview of the production and use of aggregates, is how to define aggregates. Aggregates with defined size-fraction (processed aggregates), as building materials in concrete and road structures are quite clear. However, large amounts of unsorted sand, gravel and rock fragments are also used in the construction of f.ex. roads, harbours, power plants and airfields. This study will include all these definitions in the total amount of aggregates used in Iceland per year.

### *Estimates and survey by the Public Roads Administration (PRA)*

A previous estimate of aggregate production in Iceland was made by the PRA in 1998 and indicated a consumption of approximately 5,2 million m<sup>3</sup>/year, or 18 m<sup>3</sup> per

person. This is due to the low population density, where a minimum of roads and other constructions are needed, independent on the population.

The following is the estimate of the different application in 1998 by the PRA:

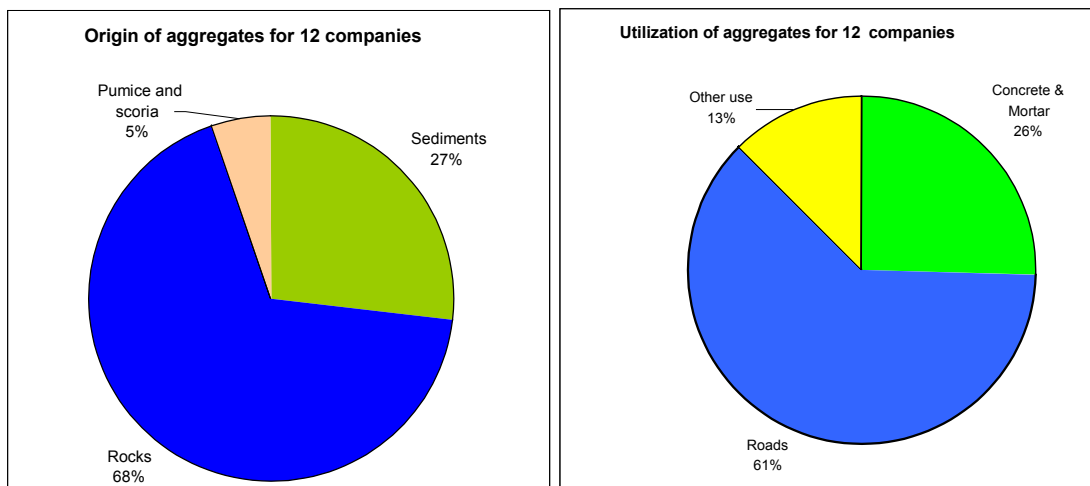
- Roads 58 %
- Streets & foundations 18 %
- Airfields & harbours 6 %
- Power-plants 8 %
- Concrete 10 %

In relation to this study, the PRA made an overview of purchased aggregate materials in 2001, giving the following numbers:

Subgrade	Base course and subbase	Wearing course	Total aggregates in road construction 2001
2.800.000 m <sup>3</sup>	1.300.000 m <sup>3</sup>	300.000 m <sup>3</sup>	4.400.000 m <sup>3</sup>

*Information from aggregate producers*

A total of 19 aggregate producers were sent a questionnaire, while at the moment we have only gathered reply from 12 of them. These produced a total volume of 1.400.000 m<sup>3</sup>, and the origin and utilisation of the aggregates are presented in figures 1 & 2. By estimating volume for the rest of the producers, we can estimate a total volume of approximately 2.300.000 m<sup>3</sup>.



**Figures 1 & 2.** Origin and utilisation of aggregate for 12 aggregate producers with a total production of 1.400.000 m<sup>3</sup> in the year 2001.

Some difference is detected between the numbers from PRA and the producers. The PRA volume numbers include the subgrade while the producers register the volumes in base course, subbase and wearing courses where the processed material is used. Therefore the subgrade material is excluded from the quantity of the aggregate

producers and accounts for the difference in quantity stated by these two sources of information.

#### *Other results*

Information on the use of Icelandic materials for ornamental stone was obtained from five major producers in the Reykjavik area. The estimated total use for the year 2001 is some 2.000 m<sup>3</sup>.

The estimated amount of aggregates for concrete used in 2001 is 470.000 m<sup>3</sup>. This is based on the total amount of cement sold during that year.

The Icelandic Maritime Administration's (Siglingastofnun Íslands) most important tasks involve responsibility for state-sponsored coastal protection and harbour projects, research, and planning for the development of coastal protections and harbours. According the 2001 annual report of the transport ministry of Iceland, the total use of aggregates in breakwaters and coastal dams was close to 400.000 m<sup>3</sup>.

#### *Import and export*

During the last years there has been an increase in import of aggregates from Norway, both for use in road surface layers, and more recently as concrete aggregates. Granite and quartzite from Norway, used for bituminous pavements, were in 1995 about 22.500 m<sup>3</sup>. In the year 2000, the total import of aggregates from Norway was estimated to approximately 60.000 m<sup>3</sup>.

The export of lightweight volcanic aggregates did increase significantly during the the years 1990 – 1995, when the export of pumice reached over 400 thousand m<sup>3</sup>. This has decreased during recent years and in 2001 only some 130 thousand m<sup>3</sup> of pumice were exported. The export is mainly to the German market.

#### *Summary of information*

Estimated amount of aggregates used in Iceland for the year 2001 is as follows:

- Roads 4,4 million m<sup>3</sup>
- Streets & foundations no information yet
- Airfields & harbours 0,4 million m<sup>3</sup>
- Power-plants no information yet
- Concrete 0,5 million m<sup>3</sup>
- Other 0,1 million m<sup>3</sup>

**Total estimated for 2001: 7-8 million m<sup>3</sup>** (based on ratios from the PRA for 1998).

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