9th Nordic Aggregate Research Conference, Reykjavik, 12-14 September 2002.

TBM Tunnel Spoil for RCC Dams and More Informative Geological Maps

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I. TBM Tunnel Spoil for RCC Dams

It is possible to utilize basalt tunnel spoil as aggregate for Roller-Compacted Concrete Dams (RCC-Dams). This can be both from drill and blast tunnels and bored tunnels (TBM-tunnels, Tunnel Boring Machines). Roller-Compacted Concrete is cement poor concrete, containing approximately a quarter of the amount of cement in ordinary concrete. The RCC is transported by trucks and conveyor belts and placed in layers and compacted like any loose earth material or aggregate in earth dam construction. RCC dams started to appear in the 1980´s and have increased dramatically in number, By 1995 there were over 200 RCC dams worldwide.

It is common to find no use for tunnel spoil, e.g. in hydro power projects as the grain size of the spoil often does not fit into conventional layered earth dam design, whereas it might be suitable for aggregate in an RCC dam. The tunnel spoil tips are damaging to the landscape and the environment and the same can be said of borrow areas and rock quarries that are needed for the construction of conventional earth dams and spillways. A ten meters high RCC dam is only 12-30% of the volume of a comparable conventional earth dams. It can survive being overtopped in extreme floods, so we do not need the extra height for the RCC dams nor a separate spillway to the side of the dam as is needed in the case of the conventional layered earth dams with the accompanying disturbance to the environment.

The main aim of RCC-dam constructions, with TBM tunnel spoil as aggregate, is to make hydro power projects more environmentally friendly, i.e. there is less disruption of the natural environment on the project site by using the tunnel spoil directly in neighbouring dams where applicable. What is accomplished is much less voluminous tunnel spoil tips as well as no disturbance in possible borrow areas and quarry sites.

RCC concrete tests of basalt tunnel spoil from hydro projects have been made from the Burfell head race tunnel, South Iceland (drill and blast) and the Eidi diversion tunnel (bored-TBM), Eysturoy in the Faroe Islands. The tests from boths these sites gave excellent results.

In addition to all this, the RCC-dams are a safer construction as water can overtop the dam in extreme floods without destroying it.

The conclusion is that RCC-dams are less damaging to the environment than conventional earth dams, especially where tunnel spoil can be used directly as aggregate for the RCC-dam.

II. More Informative Geological Maps

Until now basaltic rocks in Iceland have been classified into three main groups in the field for geologic mapping and stratigraphic purposes. These three groups have mostly been based on texture and petrology of the rock material. By subdividing each of these groups into two subgroups, based on structural differences of the whole lava unit, making up a total of six groups, we get a classification that is more relevant for engineering geology. This more detailed classification involves no more fieldwork, but provides more information from geological maps and cross sections, e.g. for engineering geologists and rock engineers planning, locating and designing structures, both underground and on the surface, in the plateau basalts of Iceland. The classification is shown in Table 1.

Table 1. Icelandic basalt classified according to rock engineering properties

<table>
<tr><th rowspan="2">Traditional field mapping of Icelandic basalts[1]</th><th rowspan="2">Proposed legend on map</th><th rowspan="2">Proposed “geotechnical” field mapping of basalts in Iceland</th><th colspan="3">Structural/Mechanical properties</th></tr>
<tr><th>Scoria content %</th><th>Common thickness of lava unit *m*</th><th>Common uniaxial compressive strength[2] MPa</th></tr>
<tr><td rowspan="2">Tholeiite basalt</td><td>Thl</td><td>Tholeiite, thin leyered, (associated with central volcaneos)</td><td>25–35</td><td>3–8</td><td>> 200 (150–300)</td></tr>
<tr><td>Tht</td><td>Tholeiite, thick (regional)</td><td>15–20</td><td>10–20</td><td>> 200 (150–300)</td></tr>
<tr><td rowspan="2">Porphyritic basalt</td><td>Pom</td><td>Porphyritic basalt esp. massive (phenocrysts > 10% by volume)</td><td>1–5</td><td>10–20</td><td>200 (100–250)</td></tr>
<tr><td>Pob</td><td>Porphyritic basalt (Phenocrysts < 10% by volume)</td><td rowspan="2">5–15</td><td rowspan="2">10–20</td><td rowspan="2">200 (100–300)</td></tr>
<tr><td rowspan="2">Olivine tholeiite (Olivine basalt)</td><td>Olt</td><td>Olivine basalt (Olivine tholeiite)</td></tr>
<tr><td>Olc</td><td>Compound lavas (from lava shield volcanoes)</td><td>0–5</td><td>20–80</td><td>100 (80–140)</td></tr>
</table>

Key words: Environment, hydro power, basalt tunnel spoil, RCC-dam aggregate, conveyor belts.
basalt classification, basalt structure, engineering geology, rock engineering,

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[1] According to G.P.L. Walker (1959)
[2] Fresh basalt