ÓSHLÍÐ TUNNEL

INTRODUCTION

A developed modern society depends greatly on good and safe transportation, be it in rural or urban areas. Good transportation is the precondition for frequent communication leading to an improved quality of life and culture in any given area.

In areas with steep mountains between fjords transportation can be a challenge. This is the case in the neighbourhood of Ísafjörður, where each village is located in its own fjord. For a long time every village was a world of its own and cooperation between one to the other was rare. Transportation was on sea and merely as a delivery of goods to and from the area. As society expanded and became more specialised these villages became too small and it became necessary to connect them better to each other. Roads through snowy mountain passes or by the ocean under steep mountain sides were not sufficient. With the tunnel through Breiðadals- and Botnsheiði 1996 a big step was made towards connecting the villages and furthermore six of them united as one community.

But more must be done. With a tunnel between Ísafjarðarbær and Bolungarvík, the two biggest towns in the area will be connected and the distance between them will be similar as between districts in a city.

ÓSHLÍÐ

The road between Bolungarvík and Ísafjörður was opened in 1950, a narrow road track along the seashore under the steep and unstable mountain hills of Óshlíð. Although that road was monumental at the time it would barely be considered a road today. However it has gradually been improved greatly, last in 1982-1989 when it was paved and two concrete portals were built at the most dangerous rock fall and snow avalanche areas. Shortly after two more portals were built, and additional precautionary actions against rock falls and avalanches were taken and the road was illuminated. In spite of that Óshlíð has always been renowned as one of the most dangerous roads in Iceland. The road has been greatly improved from its original state but with ever increasing traffic and stronger requirements for safe and reliable transportation the road is no longer acceptable as the only land connection to Bolungarvík.

The difficulties with the current road are twofold; snow avalanches and rock falls. There are over 20 known gullies from which avalanches occur regularly and rock falls can occur on numerous locations, both from slopes just above the road or higher from the very steep mountain side. Considerable progress has been made to increase safety on the road with preventive actions, such as concrete portals and steel structures, however rock falls from the high mountain cliffs is impossible to stop. Warmer weather in the last decade has also increased the frequency of rock falls.

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BACKGROUND

In 2005 the Icelandic government decided to fund the construction of a short road tunnel to increase safety on the route to Bolungarvík. The route is divided by three mountains separated by small valleys. Rock falls occur most frequently closest to Bolungarvík and the idea was to excavate an approximately 1 km long tunnel there, however it was not long after the commencing of the exploratory drilling that other possibilities surfaced. Five possible tunnel routes were investigated and discussed in a feasibility report 2006. The Icelandic Road Administration concluded that three of them should be considered.

The shortest tunnel would have been 3,8 km, with portals between the Ós-farms in Bolungarvík and in Seljadalur, a small valley close to Hnífsdalur. This would also have required improvements of the road under Búðarhyrna, the innermost mountain on Óshlíð with the least difficulties.

Another option was a 4,3 km long tunnel from Syðridalur, on the Bolungarvík side, to Hnífsdalur. The disadvantages of this option were that the access roads would have been in valleys with heavy snow and cause significant environmental effects.

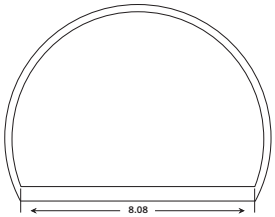
The option that was chosen suggested the longest tunnel, 5,4 km with portals by Ós Bolungarvík and in Hnífsdalur, offering the shortest way between Bolungarvík and Ísafjörður.

TUNNEL DESCRIPTION

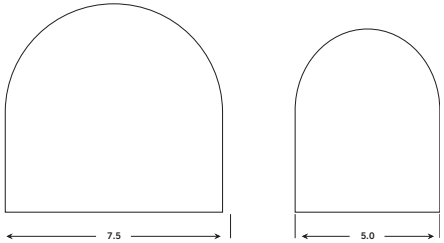
The rock tunnel is 5,1 km long, and the total length of the portals is approximately 0,3 km, so the total length of the tunnel is 5,4 km, with roughly 2% inclination at both ends.

Furthermore the project requires a new road to be built on the seaward side of the inhabited area in Hnífsdalur and a short road from Ós into Bolungarvík. Two new bridges must also be built; across the Hnífsdalur river and across the Ósá river in Bolungarvík. A high voltage cable will run through the tunnel replacing a transmission line over the mountains.

The tunnel's cross-section is circular with a width of 8,0 m at road level and the maximum height of vehicles is 4,2 m. Below the cross-section of this tunnel is compared to the ones of the tunnel through Breiðadals- and Botnsheiði.



New Cross-section



Older Cross-section - one lane and double lane

MAIN STATISTICS

Length of rock tunnel	5,1
Length of portal in Hnífsdalur	140 m
Length of portal in Bolungarvík	13 m
Height of portal in Hnífsdalur	17,3 m a.s.l.
Height of portal in Bolungarvík	11,6 m a.s.l.
Roads in Hnífsdalur	2,1 km
Roads in Bolungarvík	1,6 km
Bridge over Hnífsdalur River	8 m
Bridge over Ósá River	32 m
Tunnel width at road level	8 m
Largest width of the tunnel	8,7 m
Tunnelprofile	54 m^2
Number of Emergency lay-buses	10
Number of turning points	2
Distance between Emergency lay-buses	500 m
Number of lampposts by road	174
Fill coverage	460.000 m^3

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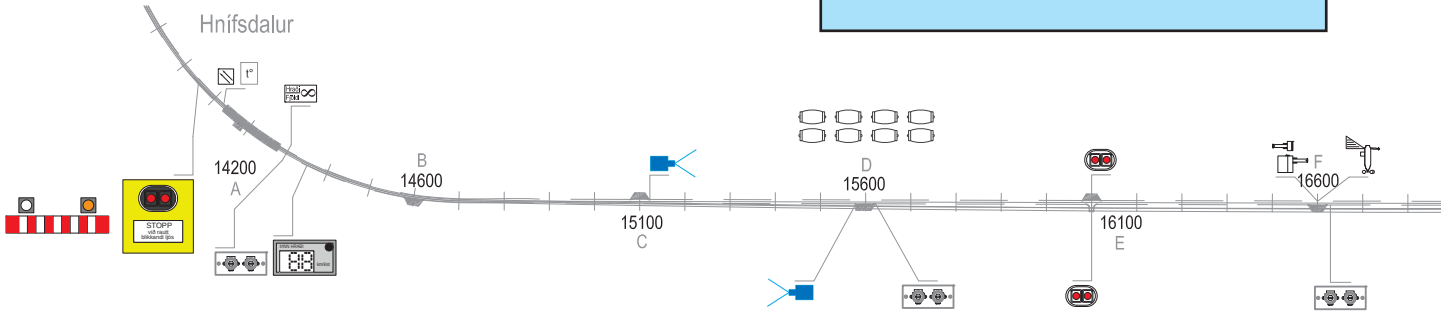
SAFETY EQUIPMENT IN THE TUNNEL

The safety requirements for tunnels have increased significantly in the past few years and safety installations in this tunnel are more than in other existing tunnels in Iceland. The heart of the safety system is a monitoring computer that gathers information from multiple sources, controls the ventilation fans and sends out alert and failure signals.

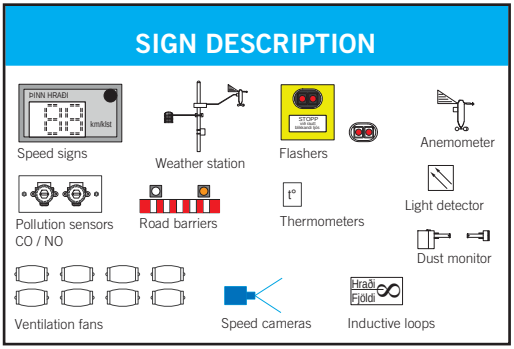
Emergency phones and fire extinguishers are located every 125 m and connected to the monitoring system so if one is moved a notification will be sent directly to the police.

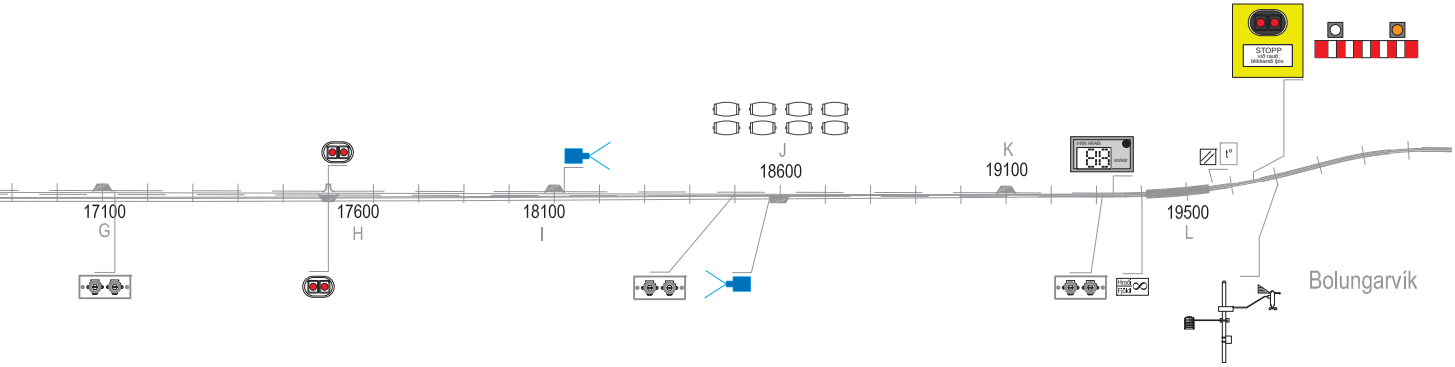
EQUIPMENT IN THE TUNNEL

Emergency phones	45
Fire extinguishers	90
Emergency escape route lighting	86
Distribution switchboards	22
Signs indicating the distance to portals	8
Signs by emergency lay buses	10
Other lit signs	aprox 100



There are sensors that measure pollution from the traffic and if it exceeds a certain limit the ventilation fans will automatically be activated. To reduce the risk of accidents it is very important to respect the speed limit. The tunnel will be equipped with CCTV as well as speedometers that show drivers how fast they are going. There will be a telecommunication system for rescue units, police and fire brigades to use in case of an emergency. Control cabinets will be located at the portals where rescue units can observe the status inside the tunnel; pollution, air speed and whether or not the ventilation fans are running. From those control cabinets it will also be possible to control the fans. Road barriers outside the tunnel will automatically be shut should the pollution exceed a certain limit. The police can also close them remotely or from control cabinets.





PROJECT COST

The construction of road tunnels is expensive compared to conventional road construction in general. The estimated total cost of this project was around 5 billion ISK after the design was completed (price level November 2007). Contractor's cost was estimated 80% of the total cost or 4 billion ISK. The total cost can be divided up in various ways to better understand the nature of it.

Tunnel excavation: Includes drilling, blasting, mucking and necessary probing and grouting.

Rock support and water protection: The rock in the tunnel is supported with rock bolts and shotcrete during and after excavation. Waterproof lining is installed where groundwater seeps into the tunnel.

The tunnel road: Includes base layers, drain system and asphalt paving.

Electrical installations: Includes lighting, ventilation fans, safety system, telephones and anything electronic.

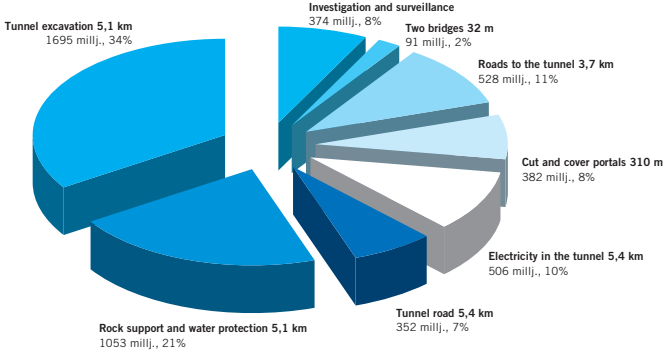
Cut and cover portals: Concrete portals are expensive; first the open excavation must be completed before commencing with the actual tunnel excavation. When the tunnel has been blasted the concrete portals are constructed in segments and finally covered with fill.

Roads: The main road system must be altered on both sides of the tunnel. This includes road fills, base layers, erosion protection, culverts, asphalt pavement, guardrails, lighting and road signs.

Investigation, design and supervision: Comprehensive investigations are necessary to find the most feasible tunnel route where exploratory drilling is the most expensive part along with geodesic mapping and environmental assessments. Then it is the final design of all the project details and the preparation of technical specifications and bidding documents. Finally, the technical supervision during the whole construction period.

An estimated cost breakdown of the project can be seen on the chart which includes miscellaneous costs and uncertainties. The division of cost can vary somewhat between contractors. The lowest bid for this particular construction was approximately 88% of the owner's cost estimate, excluding extra work and price escalation.

Cost breakdown in millions ISK



PROGRESS

When choosing the contractor a pre-qualification process was followed, where the project is introduced and the issue date of the bidding documents is given. The pre-qualification was advertised within the EEA. Contractors had to have experience with at least similar tunnel projects and have a strong financial status. Four applicants met the necessary requirements and received the bidding documents in November 2007. The bids were opened on January 22nd 2008, a contract with the lowest bidder was signed on April 8th and the construction work started in May 2008.

The construction starts with excavating the open cut at both tunnel portals. It is planned that the actual tunnel excavation will start in august 2008, and will be done from both ends simultaneously with an estimated progress of approximately 50 m pr. week from each side. The tunnel excavation could be finished in October 2009 followed by permanent rock support, water protection, drain system, final road construction and electrical installations. The tunnel is planned to be fully completed and open for traffic on July 15th 2010.

ICELANDIC ROAD ADMINISTRATION

Is the owner of the project, oversight with the project: Magnús Valur Jóhannsson, Rögnvaldur Gunnarsson and Kristín H. Sigurbjörnsdóttir. Gísli Eiríksson is the project manager of the design and will also represent the owner during the whole process.

Design and preperation:
The department of design, Icelandic Road Administration
Jarðfræðistofan ehf
Mannvit
VST, Akureyri and Ísafjörður
Raftákn, Akureyri
RTS

Contractor:
The contractors' conglomorate Ósafl;
Íslenskir Aðalverktakar, Reykjavík
Marti Contractors Ltd., Swizzerland
Local executive: Rúnar Ágúst Jónsson

Supervision:
Technical supervision during the construction period is in the hands of Línuhönnun and Geotek.
Supervisor: Björn A. Harðarson
Substitude: Hlynur Guðmundsson

Photographs:
Cover: Óshlíð, taken by Ágúst Guðmundsson
Page 2: Map of the construction area, from the bidding documents
Pade 3: Haldur 1982, taken by Ágúst Guðmundsson
Page 4: Hvanngjá, taken by Ágúst Guðmundsson
Page 8: Gully number 14, from the collection of the Icelandic Road administration
Page 10: Steinsófæra 1982, taken by Gísli Eiríksson

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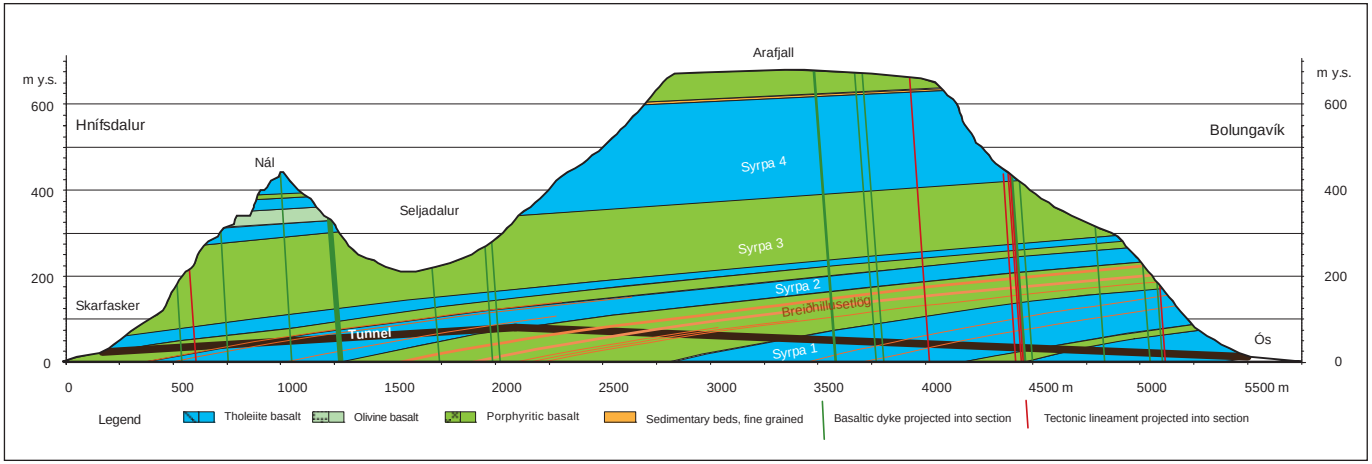

The figure shows a geological section from Hnífsdalur to Bolungavík (scale: height twice the length). The most prominent rock series and dip of strata are shown. The lowest series (Syrpa 1) contains the oldest subaerial rock in Iceland (15-20 M.y.). On the top of series 1 are widespread sediments, containing lignite which was excavated (on the surface and by tunnelling) and burned for house heating over the past centuries. These sedimentary layers are more difficult for tunnelling compared to the average rock .

The upper series, 3 and 4 have been dated 13-14 My, (which is also older than oldest rock in East and north Iceland).

Pixel ehf / GBG