Video 4a: Deep Underground Concept Tunnels and Shafts

First, let's remember four basic postulates of the Deep Underground concept:

1. **Construct underground structures in good geological conditions only.**
2. **Construct underground structures that are small in size.**
3. **Avoid using concrete and other support elements.**
4. **Avoid using heavy machinery and a large workforce.**

Next, let’s examine the conventional methods of tunnel and shaft construction.

We have two main types of underground structures: tunnels, which are circular or semicircular structures constructed horizontally, and shafts, which are basically vertical tunnels.

Conventional tunnel construction employs an excavator at the excavation face to dig material, which is then transported to the surface. The excavation face is the working area and remains the same throughout the process. The estimate for the daily average advance of a conventionally constructed tunnel is up to 10 meters.

Conventional shaft construction uses an excavator at the bottom, the shaft's excavation face. All material must be lifted to the surface. The daily average advance of a shaft is limited to about 1 meter due to safety and transportation issues.

There can be only one excavation face in the case of a shaft and usually two in the case of tunnels (for example, tunnel faces on each side of a hill). An excavation face always remains the same.

There are two main limitations of conventional construction:

1. The small shape of the excavation faces
2. The small number of excavation faces

Deep Underground addresses these limitations.

Video 4b: Deep Underground Concept — Part I

Let’s start with the Deep Underground concept.

For this demonstration, we choose to construct a 3-meter-diameter underground structure of approximately 100 meters in length in hard rock without using concrete, heavy machinery, or excessive workforce.

The picture illustrates the three steps of shaft construction according to the Deep Underground concept. The first task is to drill a borehole of 100 meters in length and approximately 10 centimeters in diameter. A borehole of this length can be drilled within a week and would cost about 10,000 euros.

The second step involves widening the borehole to a final diameter of 3 meters by removing small particles from boundaries and transporting them out of the borehole with fans or pumps. After completion, it is possible to drill another borehole from the bottom and repeat the entire procedure from a different base point.

For conventional shaft construction, the excavation face is at the bottom of the shaft and remains the same in every phase. Excavation is carried out with an excavator.

When using the Deep Underground concept for shaft excavation, the excavation face is the borehole's side wall, which increases as the borehole widens. Pumps or ventilators remove excavated material in the form of small particles.

The process is similar when working on tunnels, but the direction shifts. The key difference lies in the approach to excavation faces.

Let's explore the possibilities of a different approach.

As previously mentioned, the average daily advance of a shaft is limited to about 1 meter due to safety and transportation concerns. Using the traditional method, a 100-meter-deep shaft with a 3-meter diameter would take approximately 100 days to excavate.

Conventional shaft excavation face is always the same. It’s the circular shape of the shaft, and the area of the excavation face is 7.07 square meters for a 3-meter-diameter shaft.

According to the Deep Underground concept, the excavation face is the perimeter of the current borehole multiplied by the length of the hole (31.4 square meters when the diameter of the borehole is 10 centimeters and nearly 1000 square meters when the diameter of the hole is close to the final 3-meter diameter).

The Deep Underground concept addresses the main limitation of conventional construction, as shown in the graph. It allows excavation on a much larger area, over four times bigger at the beginning and more than 135 times bigger at the end than conventional underground construction.