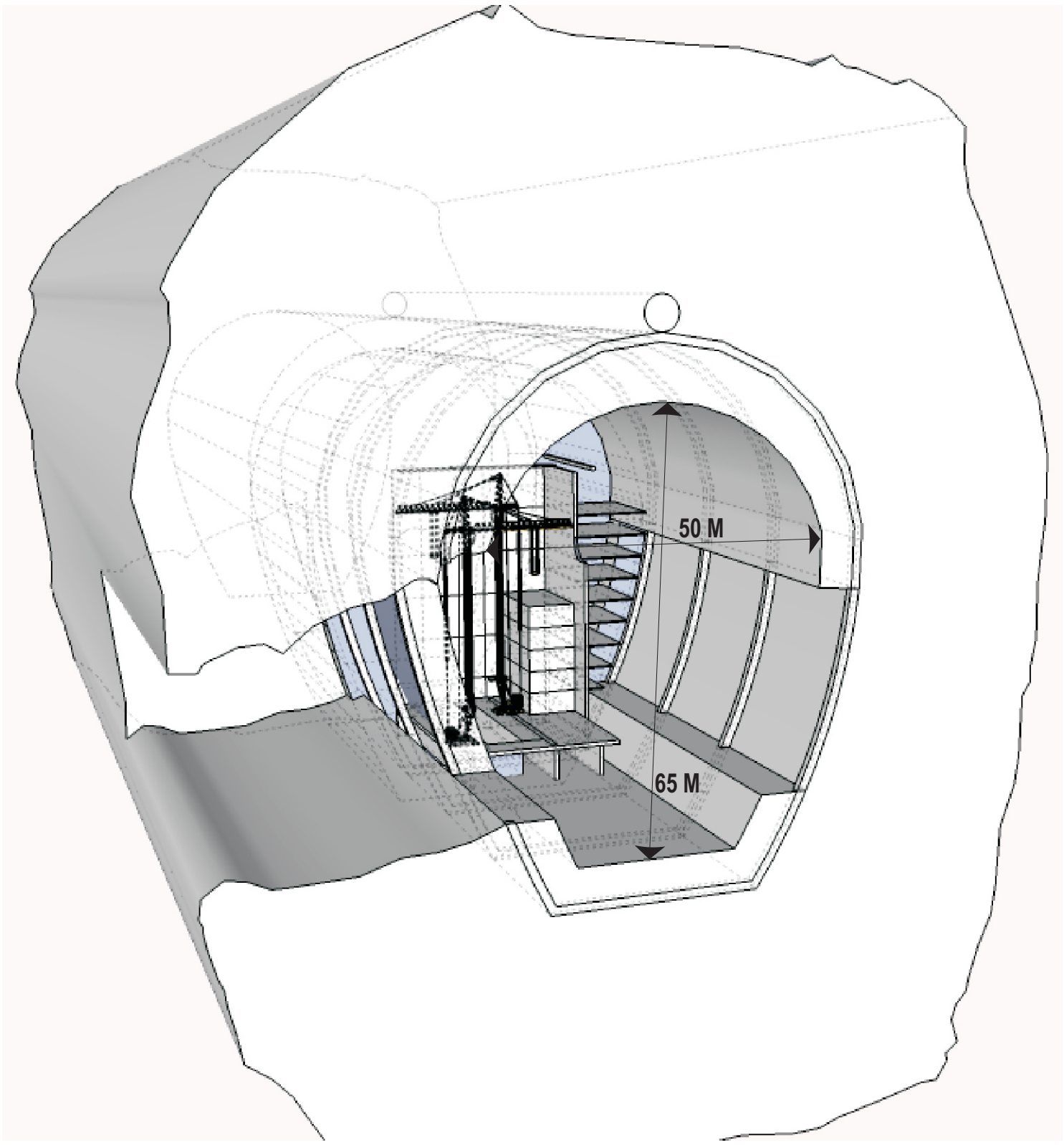
RCI AB SWEDEN



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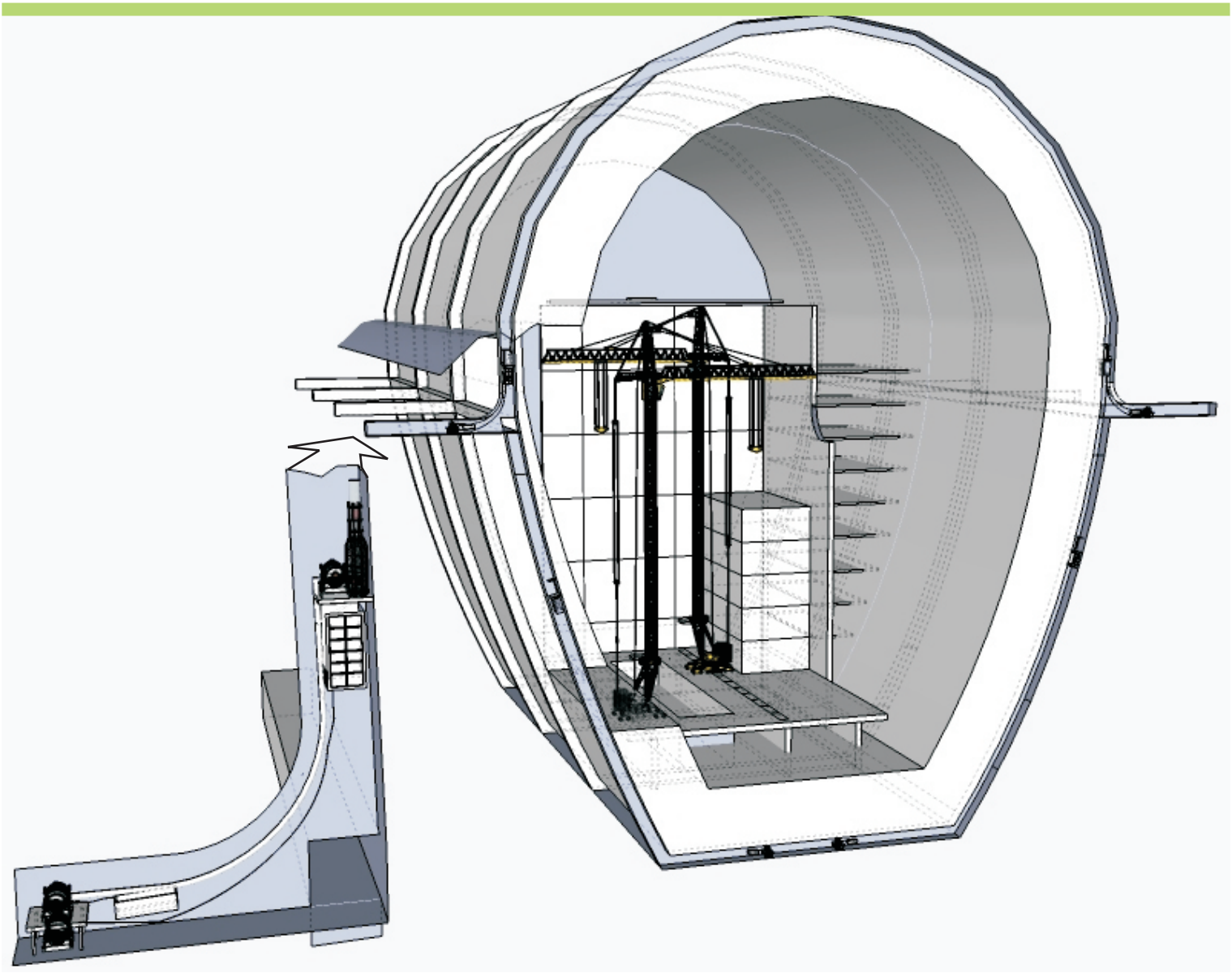
ALIMAK EQUIPMENT FOR RIB TUNNELS



The Alimak Method of raising is based on the Alimak Raise Climber with rack and pinion drive and with a guide rail attached to the hanging wall with expansion bolts. After each blast the guide rail is extended and by using curved rail sections it is possible to follow the planned curved rib tunnel very carefully. All necessary bolting and grouting is performed in the rib tunnel from the Raise Climber platform. The Alicab, the service and safety hoist, can be used for transporting material.

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RIB - IN - ROC – the philosophy

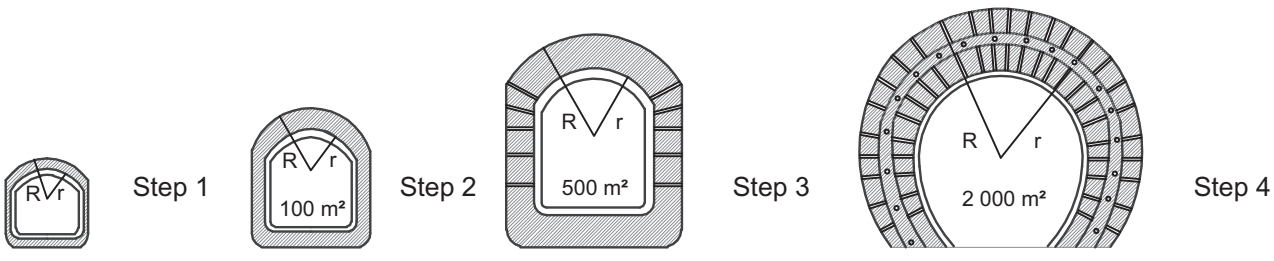
- The function of the ribs in our bodies is to provide support and protection for our internal organs
- The frame ribs in a ship act as supports and stiffeners for the shell plating or outside planking
- RIB-IN-ROC is a method for providing ribs in rock so as to reinforce rock caverns with extremely large spans

RIB - IN - ROC – the fourth step in the reinforcement of underground constructions

When a cavern is blasted out in rock, the equilibrium of the rock is disturbed. The rock strives to re-establish equilibrium and create stability by forming natural vaults. Cracks and defects occur in the rock in conjunction with this. The effects of these changes can be dealt with by means of various reinforcement measures:

- Reinforcement by means of gunite is usually sufficient for tunnels and caverns with small spans – step 1.
- When the dimensions of the cavern are increased, the gunite reinforcement can be supplemented with bolts in weak sections –step 2.
- In large rock, caverns, e.g. machinery halls for power stations, the span may amount to some 30 m. In cases like this, the gunite reinforcement is combined with system-bolted rock arches. Bolts or cables are used in conjunction with this. These directly counteract local movements in the rock and reinforce the rock in the edge zone which surrounds the void. In this way, the rock itself collaborates in absorbing forces and providing stability around the void – step 3.
- If the span is to be increased to 50-60 m, the dimensions of the surrounding rock arches must also be increased. This can be achieved by means of the RIB-IN-ROC method.

Drifts are driven in the form of arches in the edge zone outside the planned rock cavern. Bolt or cable reinforcements are installed from these drifts both in towards and out from the planned void. The drifts are finally reinforced and filled with concrete. This results in concrete arches which, in themselves, reinforce the rock in the edge zone and which also mean that the various bolt or cable reinforcements collaborate. In this way, rock arches with the required dimensions are thus also provided outside the planned rock caverns and are, in other words, created before the void is blasted out and can immediately take up loads as soon as the first equilibrium disturbances and deformation movements occur in the rock around the cavern – step 4, the RIB-IN-ROC method.



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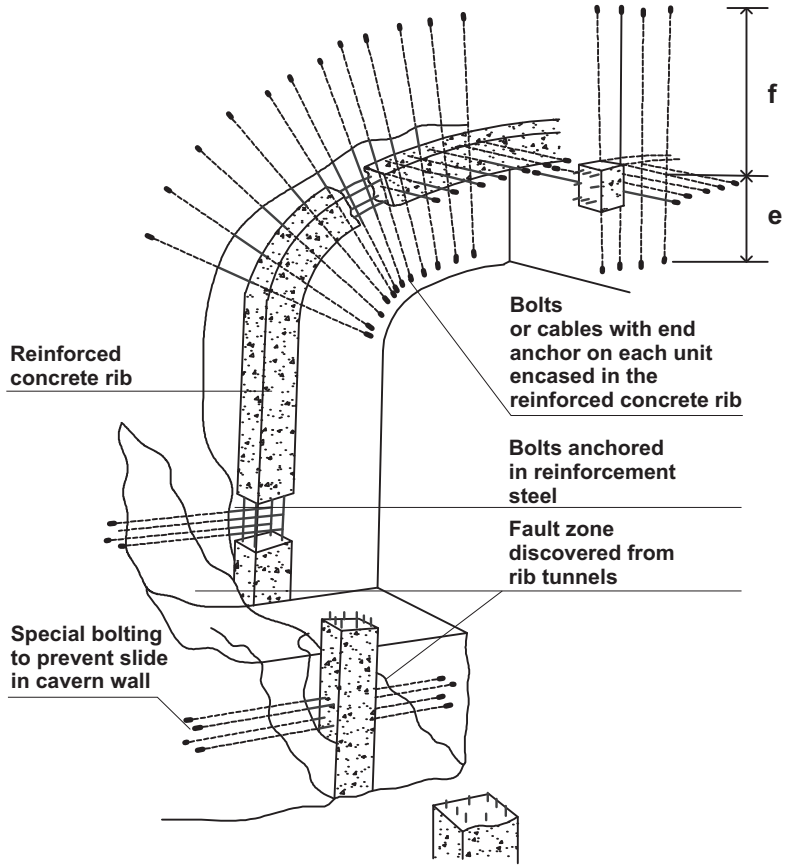
RIB - IN - ROC – this is how it is done

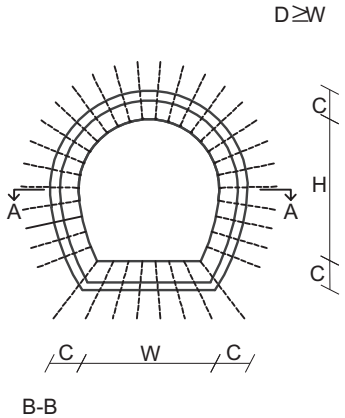
DETAIL OF A RIB



e = 8-10 m
f = 10-15 m

- Conventional methods for geological surveying are used to determine where the rock cavern is to be located and to determine its principle direction.
- Curved drifts are blasted out around the planned rock cavern.
- The rock is inspected from these drifts. The rock types involved, the strength of the rock, the main stresses, cracks, pore water pressure, water leakage and permeability are amongst the factors which must be established.

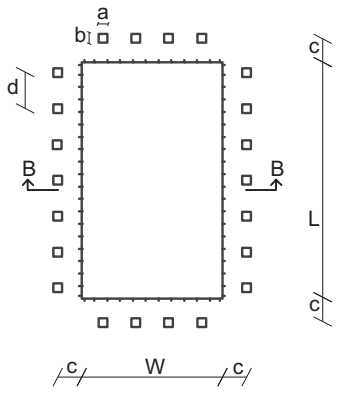
CROSSECTION



B-B

W = 50-65 m
H = 60-65 m
C = 8-10 m

TOP VIEW



A-A

W = 50-65 m
L = 100 m
a x b = 8 m²
d = 12-15 m
c = 8-10 m

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- **The data thus obtained determines**
  - the final design of the rock cavern
  - the **general** reinforcement measures which must be carried out from the drifts
  - the **local** reinforcement measures
  - the blasting method to be used
- - the working sequence

- If necessary, the effects of the measures proposed can be tested in three-dimensional model.

- Bolting and injection are carried out from the drifts in the edge zone of the planned cavern before the rock is disturbed.

- The drifts are reinforced and filled with concrete. The reinforcement system around the planned rock cavern is now completed and consists of concrete arches, reinforced rock arches and, consequently, a reinforced rock shell around the cavern.

- The formation of the actual rock cavern can now be started. The work is carried under the protection of the reinforcement structures which are now in position.

RIB - IN - ROC – a scientist's view

Professor Ove Stephansson, Luleå Institute of Technology.
Theoretical investigations of the principles involved in reinforcing concrete with ribs and model experiments with various rib types and locations have been carried out. The results show that the ribs have a reinforcing affect for both elastic and plastic rock formations. The ribs should be fully constructed before the rock cavern is blasted out if the greatest possible load absorbing capacity is to be achieved.

Professor Bengt Åkesson, Chalmers University of Technology, Gothenburg
It is well known from the theory of elasticity that the decisive stresses around a void in a loaded mass are dependent on the design of the void and not on its absolute dimensions. Rock bolting carried out from the rib drifts means that the shell which is created is twice as thick as that obtained when bolting is carried out from the rock cavern only. When a natural arch effect of this type has been established, rock caverns with spans of 50 m or more can be constructed.

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