

# An Over-View Report on Cement-Grouted Techniques Type for Rock Bolting

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## ABSTRACT:

Rock bolting is an early means of reinforcement of freshly exposed excavated rock in underground mines and tunnelling. Rock belts are installed systematically in a staggered fashion w transfer the load from the unstable exposed surface, to the stronger interior part of the rock insitu. In addition to immediate supporting of the workface, it facilitates hurdles free movement of men and machineries under the exposed area. Over the years of development, from bamboo bolts to slot and wedge type rock bolts to expansion shell type rock bolts, to anchor bolts and presently grouted type rock bolts; lot of developments have been done in the industry. In this paper, mainly development of skill in cement grouting has been emphasised and discussed. Unless, we do the cement grouting properly testing or experiments on the bolts doesn't serve the purpose of R&D.

**Keywords:** TS rock bolts grouting mixture: grouting gun

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## I. Introduction:

Among various supporting system of underground mining and tunnelling; eg chock mats, di sets, props or stulls, friction props, madras rails, head boards, cable bolting, roof stitching ele; tock bolting is an old rock reinforcement system used to stabilise the excavated surface area belowground. Here the author specifically concerns about the performance of cement grouted type rock bolts in various circumstances. Rock bolts are systematically arranged in staggered fashion so as to transfer the load from the unstable surface or exterior area of the rock, to the stronger interior part or insitu strata. The rock bolt supporting system helps both the development and stoping machinery to move freely without creating any hurdles on their way, but installing cement-grouted type rock bolts is a special skill achieved by the competent grouting personnel over the period of his experience, basing upon which the anchoring performance of the rock bolt depends. Rock bolting in mining started sometime in 1890s at St. Joseph lead mine in the US and later on, the system was developed in many ways and means. When the author was assigned the job of installing cement grouted rock bolts with a crew of three supporting personnel, sometime in 1983 in metal mines, it was a challenge to train the crew. Over the period of installation, it is the most successful rock bolting system in present days in comparison to resin capsule type grouted rock bolt, achieving the highest result so far as anchoring is concerned. Of course, rock bolter with single operator, bolts 30 to 35nos in a shift after drilling 3.25m lorig holes and bolting. In Indian scenario, it all depends on the system of operation. If mechanical maintenance crew is skilled and dedicated, then rock bolting machine is better than the former one, but again the cost of machine and competency matters a lot.

## II. CONCEPT:

When a face is blasted, the excavation exposes the foot wall, hang wall and roof; where there is likely to separate the strata layer resulting in fall of roof, hang walls or footwall. Grouted type rock bolting system binds the layers of rock into a beam along the length of the bolt, preventing these falls. So within twenty four hours of blasting the roof and hang wall need to be supported, otherwise, the exposed surface slowly sags downward and ultimately falls down causing roof falls. Equally, where required, foot wall also need to be supported soon after the blast, before further advancement of the face.

### Attributes:

At the onset, for cement grouted type rock bolting, three support personnel, soon after they finish their loose dressing, prepare Cement: Sand and Water mixture of 2-2-1 ratio. The cement taken is Portland cement and of fresh stock; sand chosen of coarse river sand duly screened off stones and normal industrial water. The crew prepares the mixture in a pan and pour it into the cement grouting gun as shown below. They fill the gun up to

the level slightly below the valve or as per the requirement. There are two: valves connected at both sides of the grouting gun installed on a tripod stand, one inlet for compressed air and the other one is a bye pass valve. The third injecting hole at the bottom of the machine is connected with a 6/7 metres 20mm plastic pipe, flexible enough to move as per the requirement. A wire (waste detonator lead easily available in the face) is tied to the injecting pipe at 60cms from distal end as a warning signal for closing the compressed air valve. The in bye end of inlet valve is connected with compressed air pipe with an air pressure of 100lbs per square inch. The leader of the team stands with one hand for opening the compressed air and the other for bye passing. As soon as the second man inserts the injecting pipe into the drilled hole, the leader opens the inlet valve slowly. The grouting mixture forced by compressed air is injected inside the hole and the mixture laden pipe is forced down slowly. As soon as the coloured wire at the neck of the pipe is visible, the leader at the gun shuts off the valve simultaneously opens the bye pass valve. Then the third man push the TS rock bolt inside with a retaining plate of 6X6 (15cmX15cm) size ms plate at the outer end. The outer end of the bolt is having a circular eye and properly welded, specifically designed for anchoring test.

Initially the face, where we were grouting, it was left for a shift without any blast in the area, but gradually we found, if the mixture was adequately prepared, even after blasting it was successful and the anchor test result was excellent.

We used to mark 10% of the grouted bolts for anchoring test, of which mostly at 15 to 18 tonnes, the welding of the eyes only got separated.

No doubt, over the early years of grouting, lacunas have been identified and to mitigate the problems, we have to be vigilant upon the followings Training: All Supervisory, manufacturing, drilling and grouting personnel should be imparted special training in addition to the refresher training imparted periodically.

#### **In bolt and retaining plate:**

The bolts and retaining plates should be checked during the manufacturing process, The eye of the bolt should properly be welded for anchor test.

Sometimes, people make 'L' shaped bolt and use without retaining plate, which must be avoided for better performance. We have reused the bolts, but it was found, the cumulative cost of old used bolts became more than the fresh ones.

The length of bolt should be chosen as per the height of slice proposed to blast down, since in some cases, we had to cut down the protruding bolts after blasting.

#### **In Drilling:**

The rock bolt holes must be drilled perpendicular to the foliation and in no way, it should be compromised; otherwise, rock bolting in that area will be fake.

The front line subordinate supervisory personnel and drilling crew should be imparted special training before deployment for the particular job and retraining of the same crew if result is not upto the mark

The crew should have sufficient idea regarding direction of drilling to install the rock bolt, since sometimes we fix scissor cut or criss cross, depending upon the joint plane and cleavage plane of the rock.

#### **In Mixture:**

The mixture should duly be made with proper measures and not of approximate.

The quality of cement can't be compromised and if not stacked properly, should be avoided.

Dusty river sand or sand collected from anywhere, shouldn't be used, especially sometimes, the crew collects sand from fire bucket or fire sand pit, which is not of good quality.

Sometimes, if neglected and the support personnel mix some amount of stowing sand in place of river sand, then the whole process goes wrong.

The muddy water of underground working while preparing the mixture should be avoided.

#### **In System**

The grouting gun along with pipe, valves and other accessories should properly be washed immediately after the grouting operation is over under close supervision to avoid blockage in the next turn. The snap couplings should have proper type of quality washers, should properly be fitted and tied with strings or wires.

The bores should be cleaned by air pressure and be checked for any sort of deformity or hurdles. During last few decades; because of continual advancement in R&D section and due to inclination educated mass towards the mining industry, today lot of work has been done in the process. The author has prepared dry capsules of same ratio of cement and sand and used in Boltecie. Rock bolting machine in the similar way as we use resin capsules for bolting and it has been observed giving excellent results).

**Different tests on the performance of grouting:**

**Destructive:**

The Conventional way of testing the bolt quality is assessed by torque wrench test or pull-out test, which is destructive. Moreover, even if we test 10% of the installed bolts, it does not ensure the quality of bolts which were not tested.

In pull out test, when a load is applied on a grouted rock bolt, the interface between the bolt and the grout is decoupled first at the point of load. The decoupling front moves towards the distal end of the bolt with an increasing applied load. The shear stress is at the level of the shear strength at the decoupling front, while behind the decoupling front the shear stress becomes smaller, since the strength of the interface has been partially lost due to decoupling.

**Non-destructive:**

It is understood over the years of analysis that grouting quality and the length of rock bolt do not comply the design standard since everything behind the rock is concealed. Non-destructive testing is preferred to pull-out test, since it is convenient, cost effective and detection range is quite high. The sound wave testing is based on the Hilbert-Huang Transform (HHT) method to calculate the length of the bolt and also to identify the locations of defect based on sound wave reflection test signals, that includes decomposing the test signal via Empirical Mode Decomposition (EMD), selecting the Intrinsic.

Mode Functions (IMF), using the Pearson Correlation Index (PCI) and calculating the instantaneous phase and frequency via the Hilbert Transform (HT). [1]

**REFERENCE:**

- [1]. Performance of Grouted Rock Bolts in Rock Mass, Subject Bhartil, Modijemishkumar V.2, Rakesh Kumar3,1, 2, 3 Research Scholar, Dept. of Mining Engineering, IIT Kharagpur, India. Email: sujetiti@gmail.com, modi@iitkgp.ac.in, ikindliya@gmail.com