Site Investigation of Support System for Haulage Road and Cross Cut in Underground Mine Excavation by Numerical Method

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***Abstract* - The conventional method of supports is generally used to excavated haulage road and crosscut of underground mine. In case of geologically disturbed areas concreting with girders is the main support. In routine formations long and short bolts with suffice the purpose. The support system by rock-bolt and shotcrete could be installed in 5 days. The calculations show clearly advantage in time and material saving. In case of geologically disturbed areas different support this support system is analyzed by numerical method with the help of FEM based software.**

***Index Terms* - Underground Mines, Haulage Road, FEM, Rock Bolt, Shotcrete.**

I.INTRODUCTION

In Underground mines the drift excavation is carried by drilling and blasting method and roof is supported by cable and steel rod bolting and in weak areas conservative concreting work is done. Recurring operation of drilling, blasting, supporting, transportation to shaft and from shaft to surface is time consuming and delay in any one of the parameters affects the efficiency. Particularly when bad ground situations are met, conservative concrete support erecting slows down the work. Hence there is a need of replacing conservative concrete support method by some another method which is faster and economical.

II. OBJECTIVE AND SCOPE

Analysis of support system of underground mine by FEM method. In metasedimentary rock formation, the Rock-Bolting create the pressure beam and artificial arching on periphery of excavated rock with immediate support after dig to avoid the fall of rock mass and uphold the size of mined drift.

III.METHODOLOGY

The analysis of rock bolt and shotcrete done by numerical approach with the help of Finite Element Method (FEM) based software. Rock bolt in tunneling and underground mining, steel rod inserted in a hole drilled into the roof or walls of a rock formation to provide support to the roof or sides of the cavity.

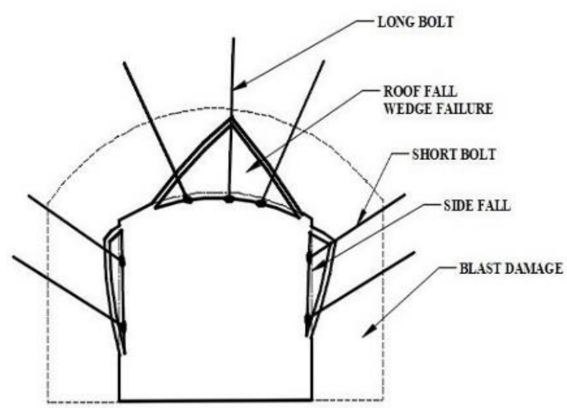

Fig. No. 1. Typical cross-section of Rock-Bolt installation

IV. MATERIAL PROPERTIES AND DESIGN PARAMETERS

Rock bolt of 1.8 m long normal to excavation boundary with 1.0 m center to center square pattern. 20 mm diameter ribbed bar (SAIL TMT 500 D) placed with cement grout of compressive strength of M10 with water cement ratio of 0.45 placed on bore hole of diameter of 30 mm (Refer fig 6.5.1).

Cable bolting of 5.0 m long 7 strand cables of total diameter of 16 mm with centralizer placing on cable on 1 m c/c, having a grout of cement paste of 0.35 water cement ratio. Drilled hole diameter of 52 mm with breathing and grouting pipe. Placing a cement grout (Birla Gold OPC 43 grade) with pressure of 6 kg/cm2(Refer fig 6.5.1).

G.I. wire mesh of 1.5 mm thickness with 65 mm x 65mm size of pattern holes placed on 2 rows and fixed with RB and CB of bearing plate of 120 mm x 120 mm of 12 mm thickness.

Dry shotcrete of 100 mm thickness of (1:1:1.5) (Cement: Sand: Aggregate) Cement of Birla Gold OPC 43 grade, Fine sand of up to 8 mm and Basalt Aggregate size 4 mm to 10 mm. Mixing of Perma Super Plast-SR as a plastizer for improve workability and work as accelerator (150 ml per 50 kg of cement) and Modified Polymer of Perma Bond SBR (Styrene Butadiene Rubber) for improvement of water resistant, increase the strength and corrosion protection. Complete mix give Compressive strength of mix is M25.

Table No. 1. Propeties of Rock core sample, Rock-bolt and Shotcrete

Sr.No.	Properties of Rock core	Value
1	Diameter of Rock Core Sample	45 mm
2	Density of Rock	2700 kg/m3
3	Compressive Strength	29 MPa
4	Young’s Modulus of elasticity of rock	2900 N/mm2
5	Poisson’s ratio	0.21 (Perpendicular)
6	Diameter of the Rock Bolt	20mm
7	Length of the Rock-Bolt	2.1m
8	Young’s Modulus of elasticity of rock bolt	2.5 x 10^7 kPa
9	Thickness of Shotceret	100mm

V. NUMERICAL ANALYSIS

The support system of underground mine is analyzed by FEM based software to check the probable settlement due to gravity load (Singh et al., 2019). The plane strain analysis is completed by Gaussian Elimination solver. The metric units are used as, field stress occurred due gravity using actual ground surface. For the analysis, mesh type is graded, and element type is 6 nodded triangles. The static analysis includes only effect of gravity loads (Pankajkumar Yadav, 2020). Ultimately, the type of failure of structure is depends upon gross pressure and point of application (Yadav P. 2018).

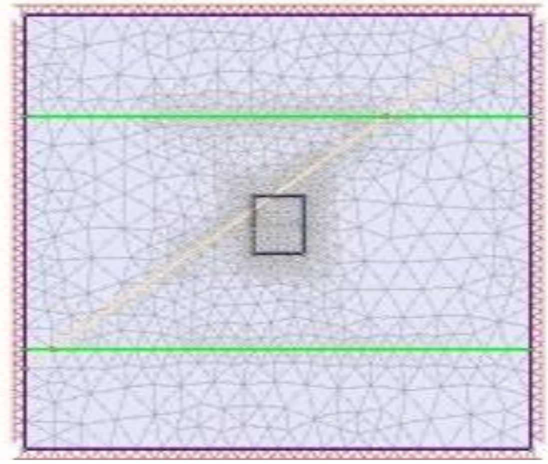

Fig. No. 2. Geometry of Underground Drift excavation location before drill.

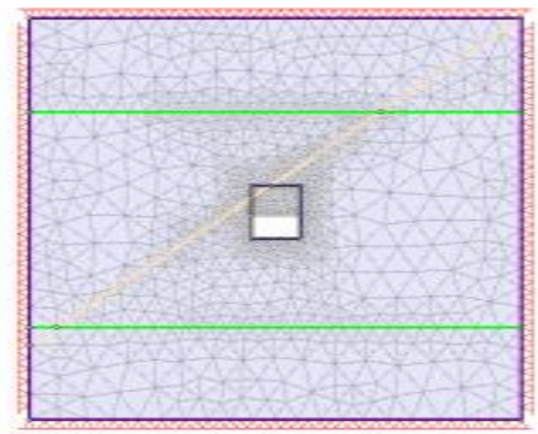

Fig. No. 3. Geometry of Half excavated Underground Mine.

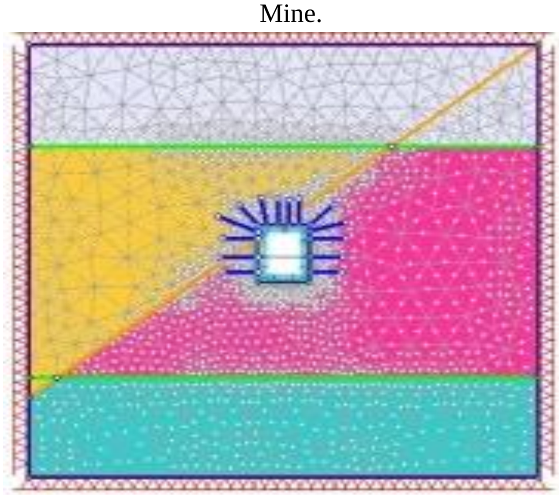

Fig. No. 4. Geometry of underground mine at complete excavation with rock bolt and shotcrete

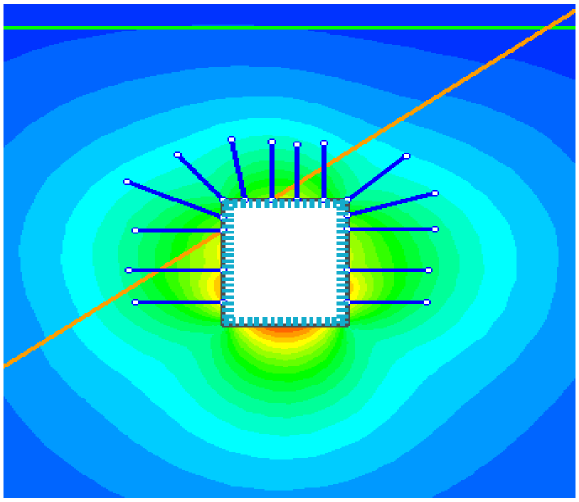

Fig. No. 4. Deformation contour of Geometry of underground mine after complete excavation with rock bolt and shotcrete

V. CONCLUSION

The numerical analysis of underground mine requires modulus properties of rocks and elements of support system. This research brings a methodology to analyze the underground mine with support system by FEM based software. The maximum settlement in the roof of horizontal drift of mine after numerical analysis is found to 3mm which is found least as compare to convergence. The rock bolt with shotcrete found to suitable for support system of underground mine.

1. Shotcreting over a length of 10m is expected to cost Rs 5,67,200 against conventional method cost of Rs 737880. It results in net savings of Rs 1,76,800.
2. The time required to do concreting over a length of 10m is usually 30 – 35 days. Shot crating over same length is expected to be done under 12 days. A minimum saving of at least 20 days of time.
3. Two 1.5m long fully grouted roof bolts at a spacing of 1.5m at a distance of 0.75m from wall width provides adequate support to 3x3m crosscut. Spacing of two rows should be kept at 1.0m

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