27 May 2010, 4:30 pm - 6:20 pm

Design of an External Waste Rock Dump in an Opencast Coal Mine Standing Against a Hill in Seismic Prone Area of India

Indrajit Roy

Birla Institute of Technology, India


Fifth International Conference on
Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics
and Symposium in Honor of Professor I.M. Idriss
May 24-29, 2010 • San Diego, California

DESIGN OF AN EXTERNAL WASTE ROCK DUMP IN AN OPENCAST COAL MINE STANDING AGAINST A HILL IN SEISMIC PRONE AREA OF INDIA

Dr.Indrajit Roy
Birla Institute of Technology, Mesra
Ranchi, Jharkhand, India

ABSTRACT

Landslides in external waste dump(i.e. waste rock material dumped outside the quarry) of Tikak opencast coal project, North Eastern Coalfield(NEC), (located in north eastern part of India) is a major hindrance to sustain coal production of 0.6-0.7 million ton per annum from NEC.

The external dump is standing against a hill slope of 8 degree inclination and the quarry operation is going on the other side of the hill (Fig1). The present height of the external dump is 80metre which is planned to be increased to 180m. The project is situated in seismic zone – V of Indian seismic map with basic horizontal seismic co-efficient of 0.08 and the vibration co-efficient in the dump due to blast vibration in the quarry is 0.06. This study discusses the methodology to tackle the above problem of Slope Stability of external dump which is planned for 180m.

INTRODUCTION

The coals of North Eastern Coalfield(NEC) are having low ash, strongly caking, high volatile and high Sulphur content. The cost of production per ton of coal from underground mines of NEC are very high and suffers a loss of nearly 170 US $ per ton of coal from underground mines. Whereas, coal from Tikak opencast mine of NEC alone contributes a profit of nearly 100 US$ per ton. As a result, NEC has decided to close some of its underground mines and with consequent stress on coal production from open cast projects/quarry for its revival. Due to above, there is tremendous pressure to increase the production from Tikak opencast project of NEC. But the nature of deposits in this quarry makes it difficult for back-filling into the de-coaled area due to which 90% of waste rock has to be dumped on the other side of the hill.

GEO-ENGINEERING PARAMETERS IN STABILITY ANALYSIS

The geo-engineering parameters, which are considered in this investigation to determine optimum combination of height and slope of external dump of Tikak opencast quarry are as follows:

* Geo-technical parameters of external waste rock dump material.

* Geo-technical parameters of rock mass in the hill over which the Tikak dump is formed.

The back analysis estimates the shear strength parameters of an existing slope by assuming that the slope is standing at limiting equilibrium i.e. by equating total stabilizing force equal to total disturbing force with the help of Fellinius method. The geo-engineering parameters other than shear strength parameters considered in the back analysis of existing dump are as follows[Fig1] :-

- Height of external dump = 80m.
- Slope of the hill = 8 degree.
- Overall Slope of external dump with respect to inclined hill slope = 30 degree .i.e. the overall slope of external dump with respect to horizontal plane = 38 degree.
- Surface width of external dump through which surface drainage due to rain water occurs = 20m.

* Horizontal Seismic force on the dump mass.
* Horizontal force in dump mass due to blast vibration in the quarry.

Geo-technical Parameters

Geo-technical parameters like Cohesion, Angle of internal friction and Bulk density after compaction to overburden

pressure equivalent to average stress within dump mass are the main factors for stability calculation of external dump.

It is pertinent here to mention that determination of geo-technical parameters in waste rock dump mass which is a heterogeneous mixture of soil and broken rocks of different size varying from few centimeter to almost a meter is considered as one of the major problematic area of external waste dump stability. As it is not possible to assess average compacting stress within external dump formed against a hill for simulating field condition in the laboratory, method of back analysis is used to estimate shear strength parameters like Cohesion and Angle internal friction.

This method finds its application in situations where (i) sampling and laboratory or in-situ testing pose problem and (ii) details of failed slopes are not available.

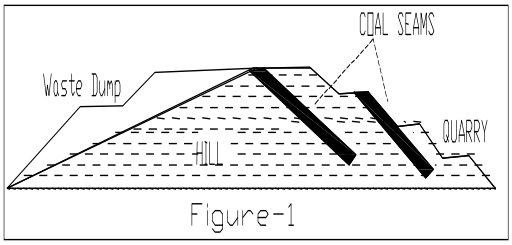

Figure-1

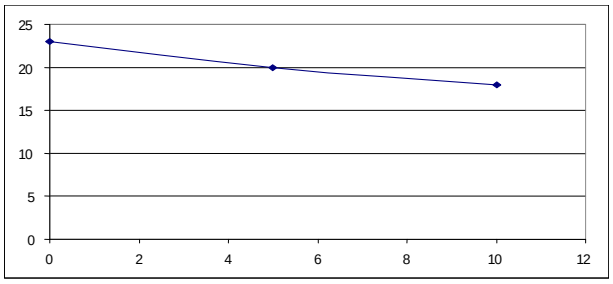

Fig2 Graph showing angle of internal friction(Deg) as Y-axis and Cohesion(kN/m^2) as X-axis.

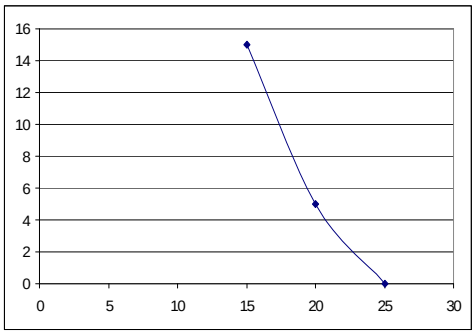

Fig3 Graph showing angle of internal friction(Deg) as X-axis and Cohesion(kN/m^2) as Y-axis.

To solve the above problem, a computer program is developed for back-analysis of existing external dump of Tikak opencast project.

The overall safe slope for 180m high dump is analysed as 24 degree with horizontal i.e. 16 degree angle of inclination with the inclined hill which is again at a slope of 8 degree with horizontal.

Following remedial measures are recommended for stabilization of external dump of Tikak Opencast mine :
- Garland drains to be provided around external dump to prevent accumulation of water at toe of such dumps.
- Application of Gabion walls will be useful for prevention of failure in the external dump.

Gabion walls are cubical wire boxes(1m×1m×1m) which will act as retaining wall to some extent resisting the active pressure exerted by the external waste rock dump.

Picture-1

Picture2