FIELD MONITORING OF STABILITY OF DUMP – A CASE STUDY

Dr. Singam Jayanthu*, and **Dr. Simantini Behera****
Professor, Associate Professor
Department of Mining Engineering
National Institute of Technology
Rourkela-769008 –Odisha

1. INTRODUCTION

Jindal Power Open Cast Coal Mine is captive mine of Jindal's 1000 MW (4 x 250 MW) thermal power plant. The block is located between Longitudes - 83°29'40" to 83°32'32" (E) and Latitude - 22°09'15" to 22°05'44" (N) falling in the topo sheet number 64 N/12 (Survey of India). Administratively, the block is under Tamnar Tahsil of Raigarh District, Chhattisgarh. The block is well connected by Road. It is about 60 km from Raigarh town, which is district head quarter and nearest railway station on Mumbai - Howrah Main Line. Scientific studies were conducted for the assessment of overburden dump slope stability using fly ash. As part of the studies, field investigations, and laboratory studies were also carried out (Jayanthu et al, 2012). Based on the various physico-mechanical properties and the field studies, empirical models and numerical modeling studies were conducted for the stability of dump slope. The ground movement monitoring for understanding stability of dump slope in the mine site was carried out with the help of the Total Station.

2. GEOMINING CONDITION

In general, area of the coal block - Jindal Power Open Cast Coal Mine is almost flat with small undulations from surface. The lithological section comprises about 3-4 m unconsolidated loose soil/alluvium. Below the top soil there is weathered shale/sandstone up to 6–8 m depth. The weathered shale and sandstone are comparatively loose in nature and can be excavated without blasting. Below weathered zone (which varies from 3 – 10 m), the rock is hard, compact and massive in nature and can be excavated only after blasting. Thus the average depth of the excavation of these excavations, which can be removed, is about 16 m.

In the sub-block IV/2 & IV/3 only lower groups of Gondwana sediments have been deposited. Strata are gently dipping by 2° to 5° southwesterly. The general strike of the sediments is in NW-SE, and almost uniform throughout the block. Two normal faults of small magnitude have been deciphered based on the level difference of the floor of the seams, though the presence of some minor faults of less than 5 m throw cannot be overruled.

The Mand Raigarh basin is a part of IB River - Mand - Korba master basin lying within the Mahanadi graben. The sub-block IV/2 & IV/3 of Gare-Pelma area is structurally undisturbed except one small fault (throw 0-15 m) trending NE-SW with westerly throws. The strike of the bed is NW-SE in general with dip varies from 2° to 6° southwesterly. The strata shows rolling dip. In the sub block IV/2 & IV/3 total 10 number of persistent coal seams have been established. They are seam X to I in descending order. Seam I is impersistent due to metamorphism in the central and eastern part of the block. Depth of mine working is about 36 m with six benches of 6 m height. Ultimate depth of the mine would be about 120 m from RL of 271 to 151 m. Back hoe in combination of dumper with 6 m bench height is adopted for excavation in the mine. It is also proposed to have 6 m height benches at the time of formation of ultimate pit slope.

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Bench parameters being followed at present are

Bench height	= 6 m
Numbers of working benches	= 6
Width of the bench	= 20 m
Gradient of the ramp	= 1 in 16

3. METHODOLOGY FOR DUMPING OF FLY ASH

It was proposed earlier to have internal overburden dumps of maximum height of 30 m in each individual deck with four decks up to 120 m overall dump height. Presently overburden dump height is about 72 m with a maximum deck height up to 25 m in this mine. These dumps and slopes are observed to be stable at present. Stability analyses for the proposed dumps were undertaken using various techniques for the maximum dump height of 120 m, which is the ultimate depth of the mine. Ground Water level conditions are below the 13 m from the surface and benches are generally dry. Jindal Power Limited, Tamnar has already have captive thermal power plants of 1000 MW and generating fly ash, a solid coal combustion residue form due to the burning of coal, of nearly 16000 tons per day. Therefore, quantity of fly ash generated requires large area for its dumping. In last two decade it was realized that fly ash is no more a waste. Its utilization has increased by several folds, and particularly in mining industries. Fly ash is being used at JPL along with overburden material for backfilling in the mine as per the DGMS guide line (Fig 1). The following methodology was adopted for the dumping process:

Section for the dumping of fly ash at Jindal Power Open Cast Coal Mine, Tamnar is represented in Figure 2. Initially a row of overburden was dumped forming an embankment with a width of greater than 15 m and height up to 5 m all around the proposed area for fly ash dump. A number of such areas were formed in a layer wherein the fly ash was dumped so that each dump of fly ash was separated by another overburden dump of 15 m wide in order to control the airborne quality of the fly ash. Fly ash was dumped within this area surrounded by overburden in alternate layers of height not exceeding 5 m in each layer and dozed (Fig 3). Therefore, each layer of overburden was followed by a layer of mixture of fly ash and overburden (fly ash 25%) and so on up to the height of 30 m. The side of the overburden dump is benched and the angle of slope is about 28°. Dump is compacted; width of the dump is about 40 m and the overall slope is about 21° from the horizontal. The toe of the dump is protected by putting the compact rocks (Overburden material) in order to restrict the possibility of any failure in future.

Fig 1: A view of dump with fly ash and Over burden material

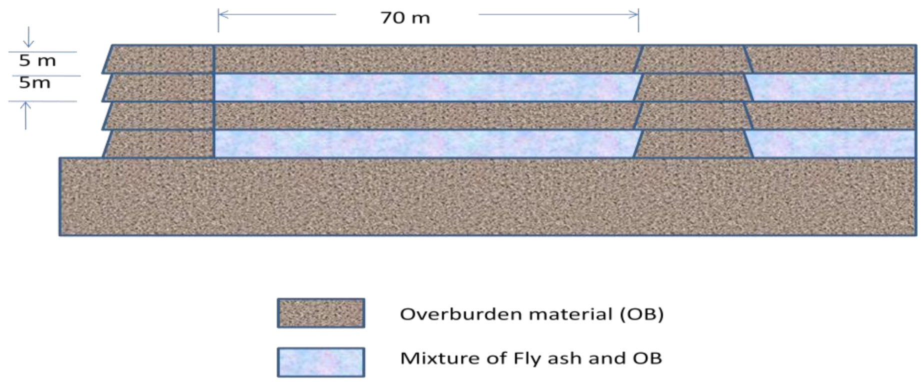

Fig 2: Section of the dump

Fig 3: Dozing of flay ash and OB material at the dump site

It is observed that dump with alternative layer of overburden and overburden mixed with fly ash (25%) is found to be stable with safety factor more than 1.2 for the following geometry of the dump:

- Total height of the dump: 120 m
- Number of decks: 4
- Height of individual deck: 30 m
- Slope of each deck: 32°

For the long term stability of the slope following suggestions are made:

- Top soil should be protected against rainfall by taking measures like plantation, geosynthetics, or jute/coir reinforcement.
- The compaction control should be periodically checked for proper compaction of overburden and fly ash mixture.
- As it was observed rainfall intensity is high during monsoon/cyclone, so gully drains may be provided along the slope at regular intervals.
- Toe walls and peripherals drains may be required after observation of the dump slope during heavy rainfall.

6. SLOPE STABILITY MONITORING

As per the DGMS permission for fly ash filling in opencast working along with overburden, height of dump was limited to 30 m. The height of dump at study site was about 25 m. Final stage dump consist of 2 m top soil above the layers of OB and OB mixed fly ash material.

Stability of Dump slopes was monitored with total station and monitoring stations fixed at an interval of 20 to 30 m on the dumps at a distance of about 5 m from the crest of the dump slope (Fig 4). 47 monitoring stations were installed with 1.0 m long pipes and masonry pillars; 23 stations in the Pit 1 and 24 stations in Pit 2 and total station was used for measuring RL of the stations (Fig 5).

Fig 4: Monitoring stations at an interval of 30 m on the dumps at a distance of about 5 m from the crest of the dump slope

Fig 5: Total station for measuring Reduced Levels of monitoring stations

Reduced Levels of monitoring stations during Nov'12 to the end of March'13 indicated maximum Vertical displacement of -0.018 m was noticed in Pit 1, while the Vertical displacement was limited to -0.01 m in Pit 2. Negative displacement may be considered as settlement of the material over time. The analysis of the RLs of the monitoring stations in Pit-1 and Pit-2, indicates that more than 50% of the stations showed no further displacement. Monitoring station KJS2 was disturbed due to movement of the machinery. Few stations showed no trend in vertical deformation as they showed downward as well as upward vertical displacement from Nov.2012 to the end of March 2013. This irregular deformation pattern may be due to differential settlement and consolidation of the material near the monitoring stations (Singam Jayanthu, and Simantini Behera, 2013).

Incremental downward vertical displacement of about 30% of the monitoring stations indicates gradual settlement of the material, which may settle further in due course of time. It does not show any accelerating trends in deformation which is one of the indicators of slope failure. It necessitates further study of these stations till total settlement occurs. As the dump was formed only a year back, it may be inferred that settlement of the dump material at some places may take more than a year. Thus further monitoring of reduced levels of the stations may be continued till all the stations show complete settlement.

Table 6: Status of vertical displacement of dump at the monitoring stations

Zero displacement		Downward displacement		Haphazard displacement	
Pit-1	Pit-2	Pit-1	Pit-2	Pit-1	Pit-2
AS1, AS 2, AS 3, AS 12, AS 13,AS14, AS 15, A16, AS 18,AS19, AS 20, AS21	KJS6, KJS 7, KJS 8, KJS 9, KJS 10, KJS 13, KJS 14, KJS 15, KJS 16, KJS 17, KJS 18, KJS 20, KJS 22	AS4, AS 6, AS 7 , AS 9, AS 10, AS 17, AS 22, AS 23	KJS 1, KJS 4, KJS 11, KJS 12, KJS 19, KJS 23, KJS 24	AS 5, AS 8, AS 11	KJS3, KJS 5

Figures 6 and 7 shows the variation of reduced levels of different stations in Pit 1 and Pit 2, respectively. Except at station KJS2 in Pit 2, all the stations showed no perceptible variation indicating stability of the dump material. Plantation on the same dump is under progress with successful survival rate of the species such as banana, Teak, mango etc.

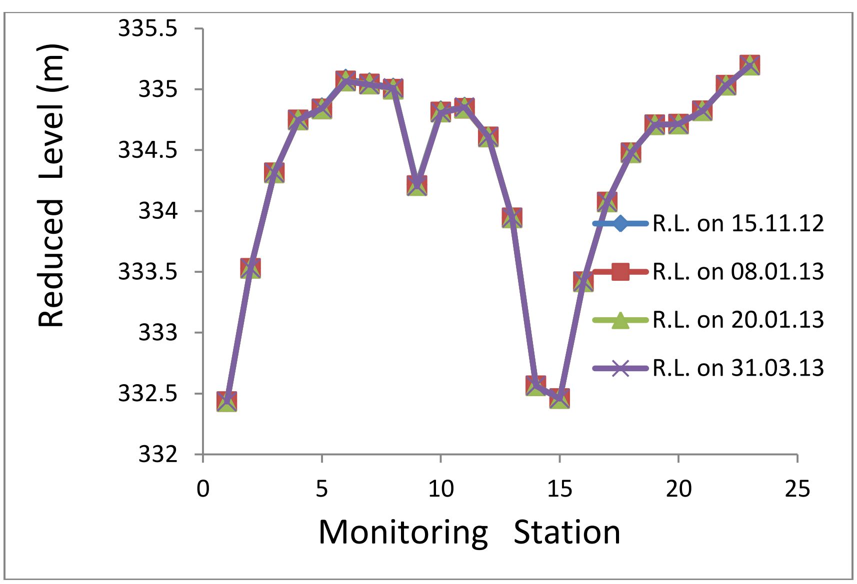

Fig 6: Variation of RL of the Monitoring stations over the dump material in Pit 1

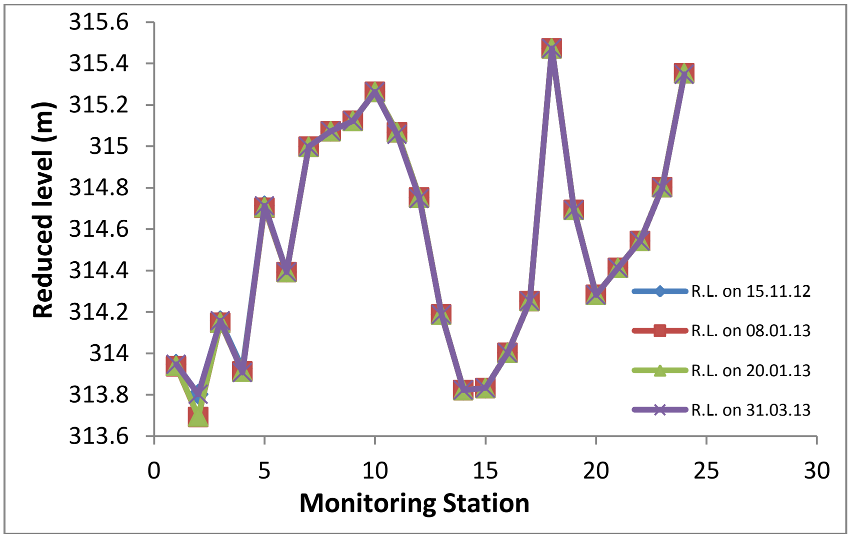

Fig 7: Variation of RL of the Monitoring stations over the dump material in Pit 2

CONCLUSIONS

Displacement pattern of the monitoring stations during November 2012 to the end of March 2013 indicated no significant displacement in the Overburden dumps with fly ash ensuring stability of the dump near majority of the stations. The dump is in the process of continuous settlement near 1/3rd of the stations. Therefore, further monitoring of reduced levels of the stations may be continued till all the stations show complete settlement.

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