CHAPTER 4

SIMULATION OF MINING SYSTEM OF VARYING DEPTH

Opencast mines are going deeper day by day due to increase demand of coal and mineral and depletion of coal at shallower depth. Depth is a very important parameter in opencast mining method. A mine has to go deep in case of steeply dipping coal seam. The increase in mine depth requires expansion of the mine in all the directions. This is required to reach deeper part of the mine by maintaining required overall slope angle to avoid any slope failure. This results increase in volume of overburden to be extracted to expose the coal seam for extraction. The excavated overburden material are dumped directly inside the mine. This has been termed as internal overburden dump. As the mine depth increase, the height and the area required by an internal overburden dump would also increase many fold. The production achieved from the deeper part of the mine also requires a haul road to bring out the material to the surface from the deepest face of the mine. The haul roads are required to bring the material from deepest part of the mine up to the surface. It is also essential to maintain a proper gradient. It is obvious that as haul road length would also increase so that hauling machineries can move safely.

4.1 Simulation of mining system

Mine 'B' has been taken for this study. Mine 'B' has been simulated at various depth for this study. The first simulation has been done at 50 m depth. Other simulations of mine 'B' has also been carried up to an ultimate depth of 250 m at an interval of 50 m. Hence, five simulation processes have been adopted. Therefore, five mining systems have been taken for simulation i.e. at a depth of 50 m, 100 m, 150 m, 200 m and 250 m. The area of the mine is comparatively smaller when the depth is 50 m (shallower depth). This area increases with increase in depth. It is 1 km^2 at the depth of 50 m, 1.5 km^2 at the depth of 100 m, 2.5 km^2 at the depth of 150 m, 3.5 km^2 at the depth of 200 m and 4 km^2 at the depth of 250 m. Its strike line swings from east to west.

In the area chosen for open cast mining under Mine 'B', only single seam is proposed to be worked. The average thickness of the coal seam is 38 m which varies from 30 m to 40 m. The average working stripping ratio is 6 and average gradient of the coal seam is 1 in 15.

Shovel dumper combination has been adopted for mining of coal. The capacity of the shovel is 9 m^3 and the capacity of the dumper is 45 tonnes. The transportation of the coal from face to the surface has been done by dumper and from surface to stockyard has been done by trucks.

The mine 'B', studied at varying depths for this study, has been shown in figure 4.1 through 4.7 with different stages. Figure 4.6 shows the section of the opencast mine 'B' at 50 m, 100m and 150 m depth of the mine whereas figure 4.7 shows the shows the section of the opencast mine 'B' at 200 m and 250 m depth of the mine . It can be seen from the figure 4.1 through 4.5, as the mine is getting deeper in nature, it expands laterally in all the direction. Deeper mines has covered more area, in comparison of shallower one.

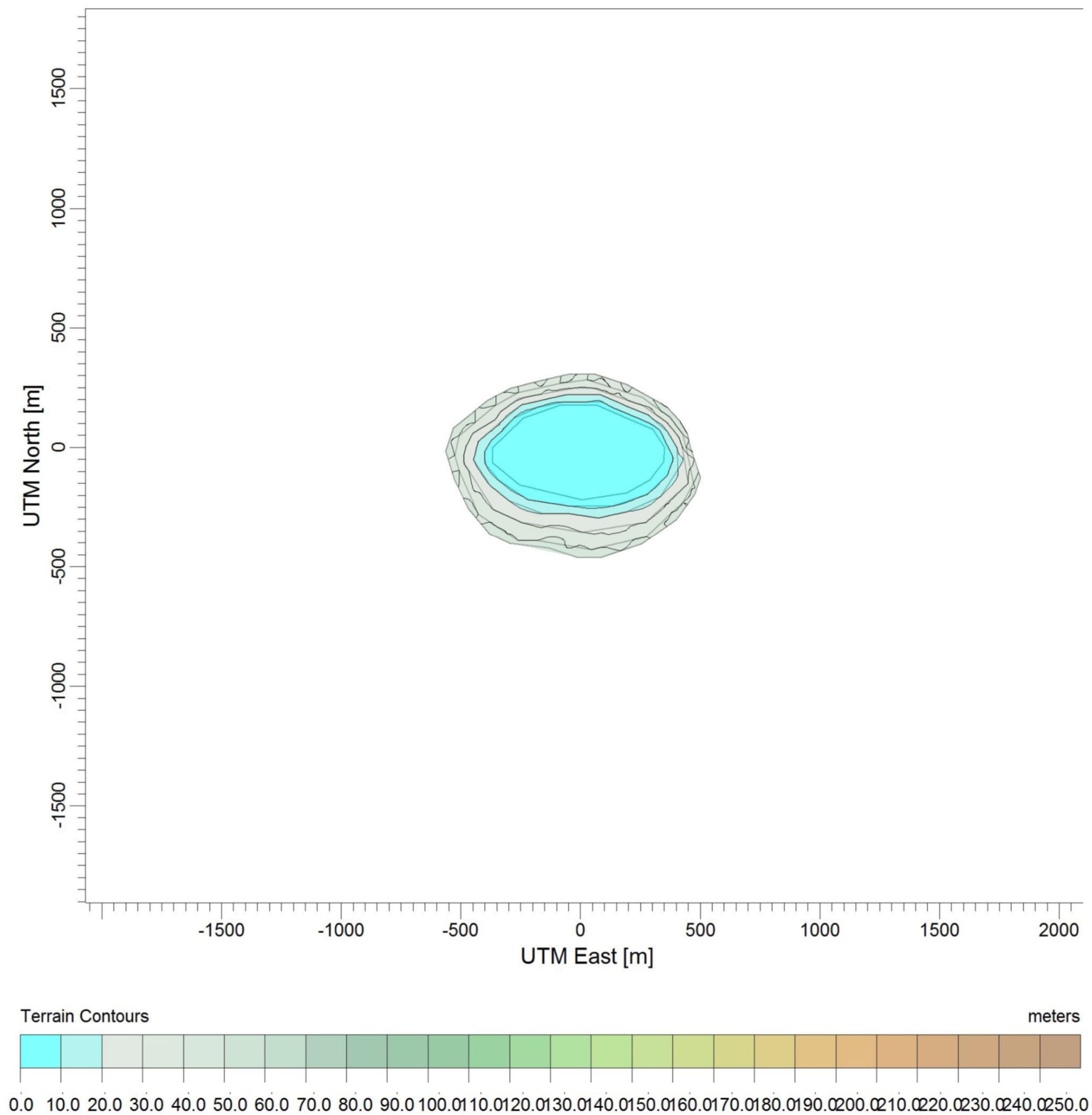


Figure 4.1: Terrain Contours of Mine 'B' at 50 m depth

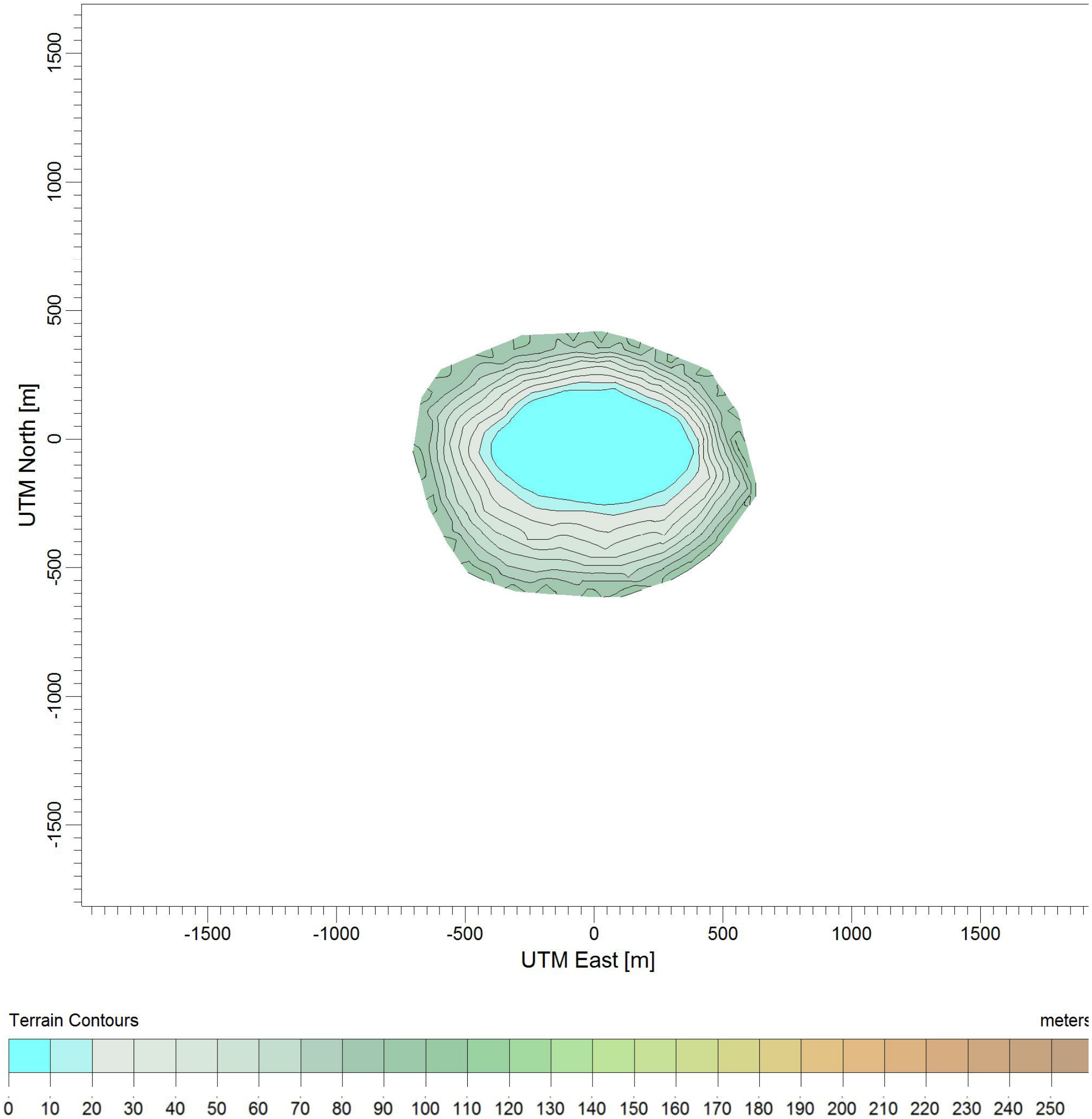


Figure 4.2: Terrain Contours of Mine 'B' at 100 m depth

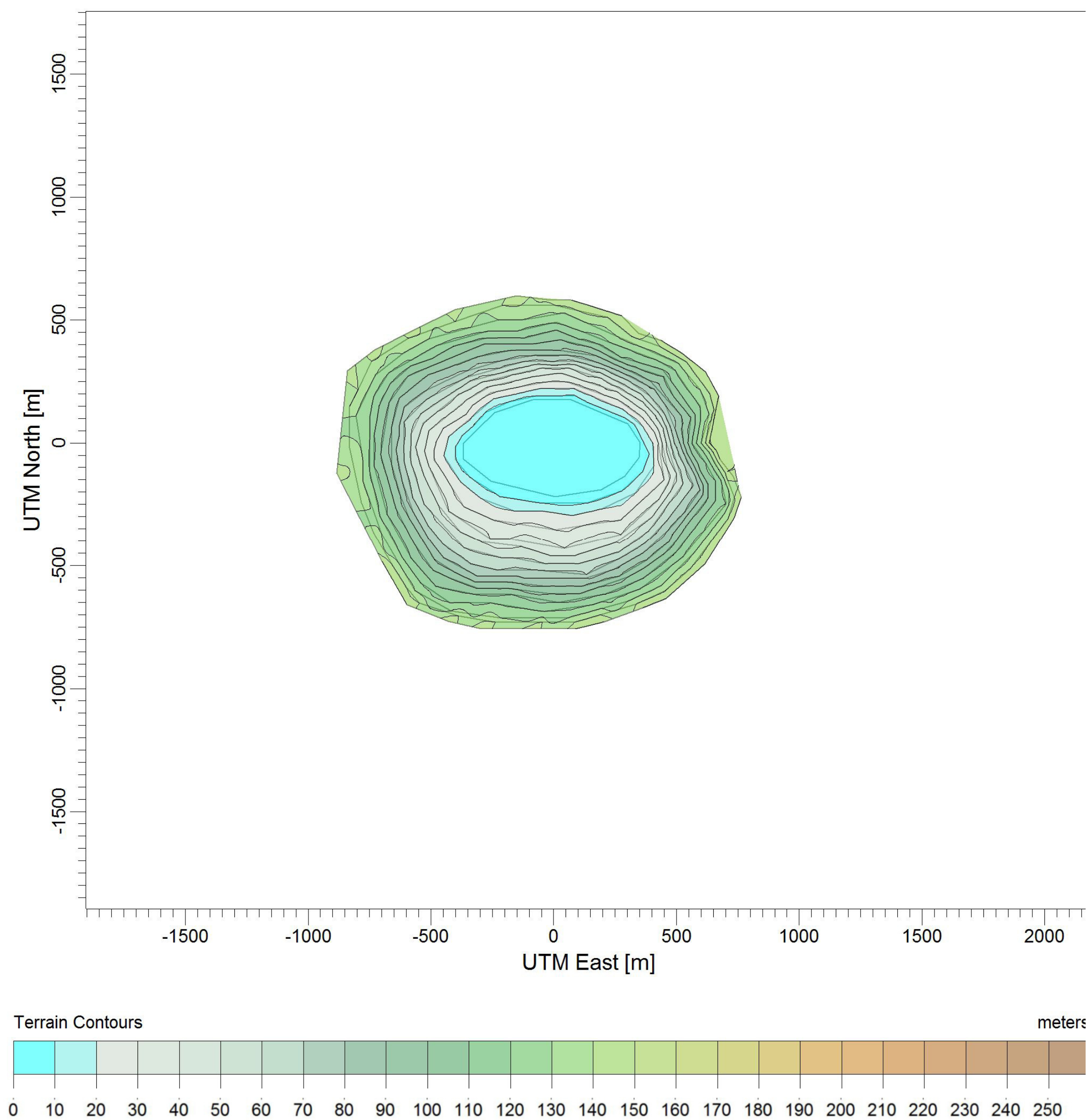


Figure 4.3: Terrain Contours of Mine 'B' at 150 m depth

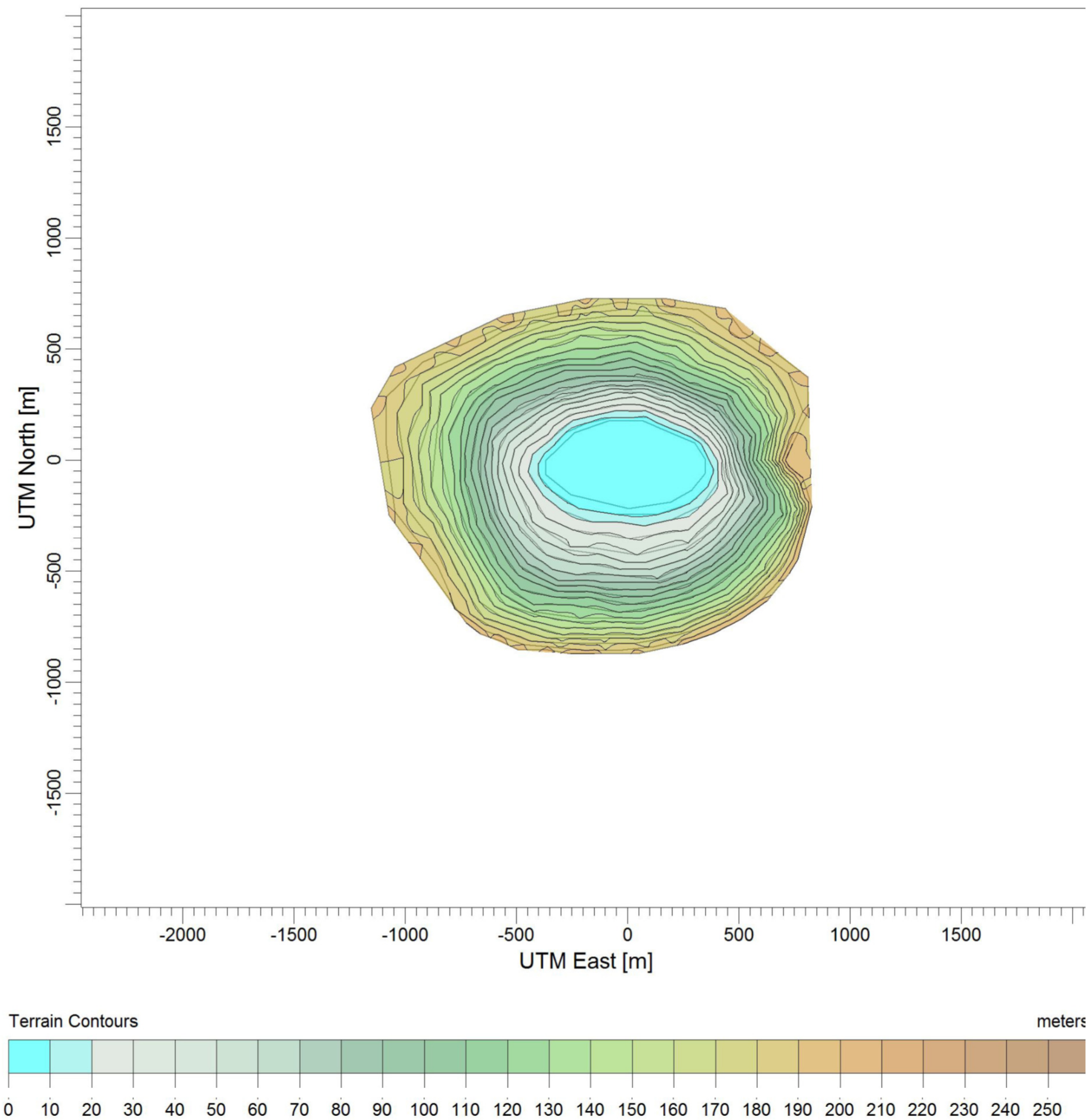


Figure 4.4: Terrain Contours of Mine 'B' at 200 m depth

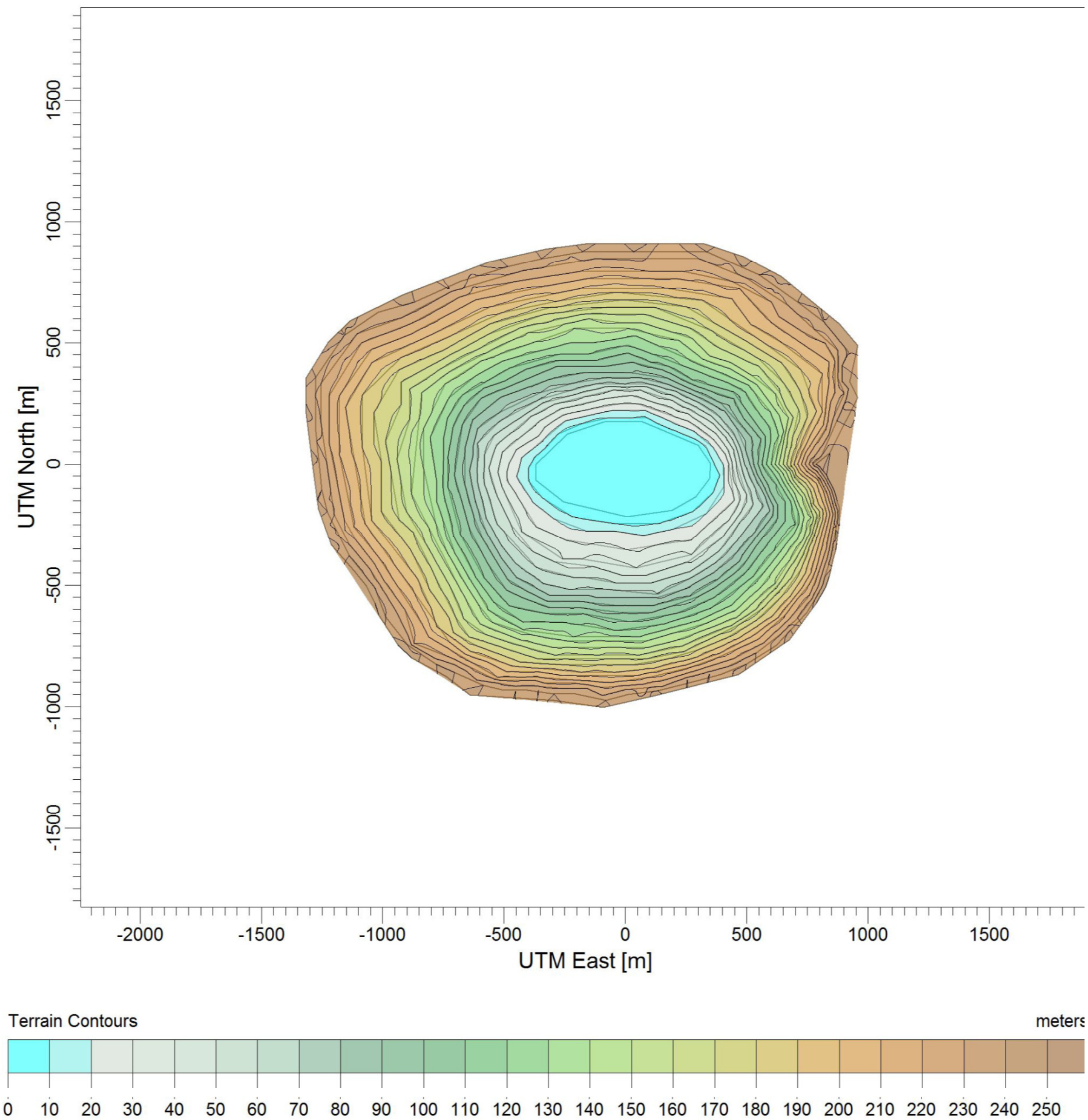
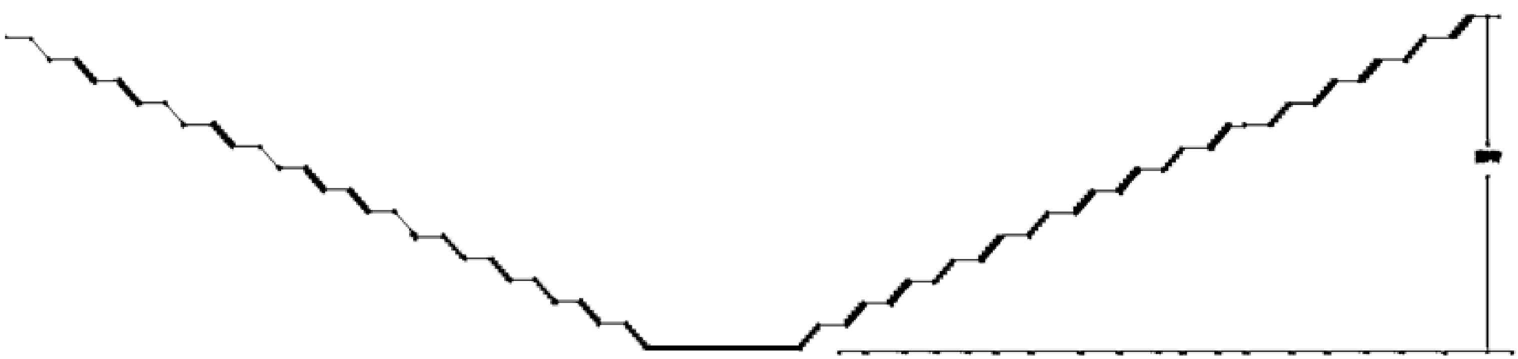


Figure 4.5: Terrain Contours of Mine 'B' at 250 m depth

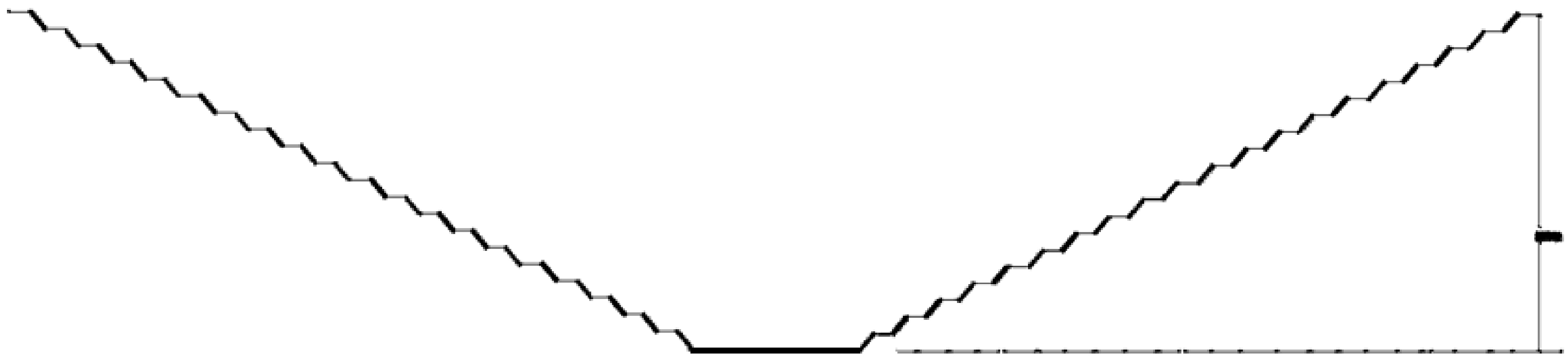
(a)

(b)

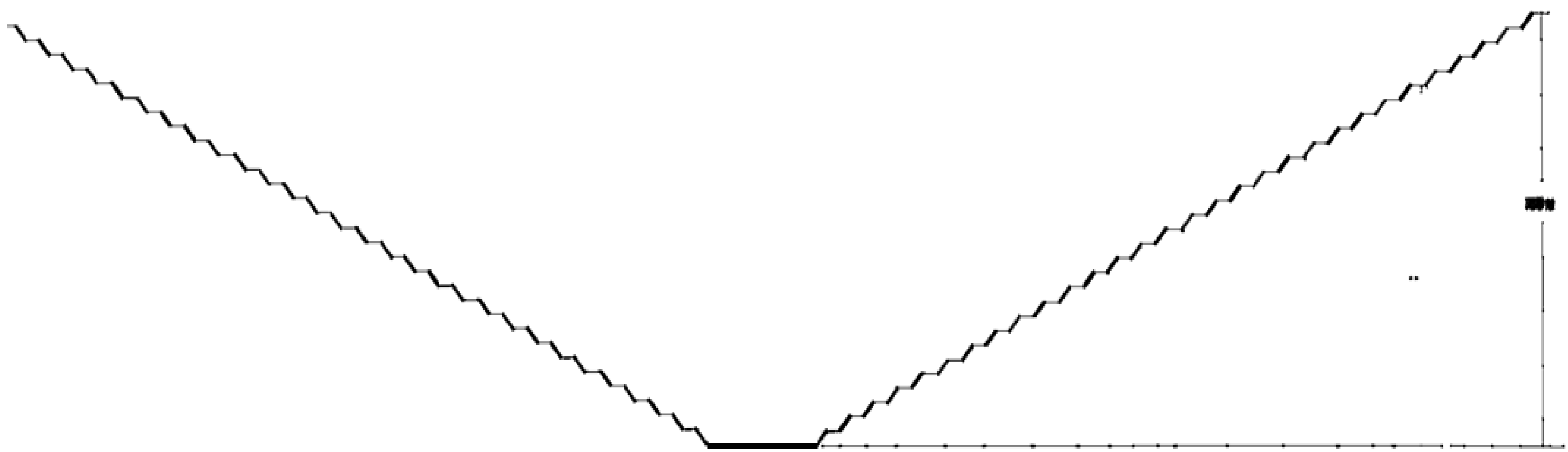


(c)

Figure 4.6: 50 m (a), 100 m (b) and 150 m (c) depth section of Mine 'B'



(d)



(e)

Figure 4.7: 200 m (d) and 250 m (e) depth section of Mine 'B'

4.2 Simulation Process

There were different sources considered for the modelling of PM_{10} in the different depths of mine ‘B’. Simulation of dust dispersion was carried out for different cases by considering different sources at a time. These cases are described in subsequent discussion in this chapter.

4.2.1 Simulation of a mine at varying depth

All the sources have been kept at the bottom most part of the mine for all the depths in the first part of this study. This has been done to find out the impact on environment of particulate matter outside the mine considering that all the activities are going at the deepest part of the opencast mine. In this section of the study, dust dispersion modelling has been done for five different depths of mine ‘B’ as shown in figure 4.1 to 4.7. In each depth of the mine, two dust sources were used at the bottom most part of the mine. These sources were two types in nature. Point and Line area sources were considered for the simulation process. A working face was defined as point source in the bottom most part of the mine ‘B’. This was done to take in to consideration that the working is going on the mine at the bottom most part of the mine at different depths. In prolongation of this, a haul road was also defined as line area source in the similar manner at the bottom most part of the mine ‘B’ at different depths. Table 4.1 shows the location and other details of the dust sources used in this part of the study.

Table 4.1: Description of dust sources for study on dispersion of pollutant from different depth of mine ‘B’

S. No.	Type of Source	Source Id	X – Coordinate (m)	Y- Coordinate(m)	Dimension/ Height (m)	Emission rate
1.	Point	COAL FACE	-19.71	150.35	5	0.143 g/s
2.	Line Area	ARLN1	-334.45	-26.64	0	0.00213 g/sec-m^2

All the parameters mentioned in the Table 4.1 were kept same for all the depth of the mine in this part of the study. Contours of the PM_{10} concentration levels were simulated outside the mine for different depths of mine and analysed later to get the results.

4.2.2 Simulation of internal overburden dump with varying depth

Another part of the study has carried out using different volume of internal overburden dumps only. This has been done to find out the impact on environment of particulate matter outside the mine considering that emission of dust was taking place only by single source i.e. internal overburden dump. This was done to find out the changes in the concentration levels of particulate matter outside the mine from the different volume of internal overburden dump at varying depth of the mine.

These overburden dumps of different volume has been considered at different depth of the mine 'B' as shown from figure 4.3 to 4.7. At initial 50 m depth of the mine, the volume and height of the overburden dump was less but as the depth of the mine had increased, the volume of the extracted material was also increased due to expansion of the mine in every direction. Due to this the area to be covered from the overburden dump was to be increased to accommodate the extracted overburden. Subsequently the height of the overburden was also increased to fill the extracted portion from the excavated overburden inside the mine as it is practiced in opencast mining. Table 4.2 shows the location and other details of the dust sources used in this part of the study.

Table 4.2: Description of dust sources for study on dispersion of pollutant from different height of overburden dump of mine 'B'

S. No.	Type of Source	Source Id	X – Coordinate (m)	Y- Coordinate (m)	Height (m)	Emission rate
1.	Area Polygon	OVERBURDEN 50	-280	35	60	4.3 x 10^{-6} g/sec-m^2
2.	Area Polygon	OVERBURDEN 100	-280	35	120	8.9 x 10^{-6} g/sec-m^2
3.	Area Polygon	OVERBURDEN 150	-280	35	180	1.3 x 10^{-4} g/sec-m^2
4.	Area Polygon	OVERBURDEN 200	-280	35	210	2 x 10^{-4} g/sec-m^2
5.	Area Polygon	OVERBURDEN 250	-280	35	270	2.54 x 10^{-4} g/sec-m^2

The centre point of the overburden dump was same as visible from X and Y coordinates in Table 4.2. But as the depth had increased from 50 m to 250 m at an interval of 50 m of the mine, height of the overburden dump was also increased 60, 120, 180, 210 and 270 m for 50, 100, 150, 200 and 250 m depth of the mine 'B' respectively. The area covered by overburden dumps had also increased to accommodate more excavated material inside the mine as 2, 14, 347 m^2, 4, 23, 414 m^2, 6, 94, 462 m^2, 11, 15, 542 m^2 and 13, 90, 364 m^2 for 50, 100, 150, 200 and 250 m depth of the mine 'B' respectively. Emission rate for different height of the overburden dumps calculated in the similar manner as in previous chapter from the equation mentioned in the Table 3.2 for exposed overburden dump.

4.2.3 Simulation of haul road with varying depth

Similar kind of study has been carried out using different length of haul roads only. This has been done to find out the impact on environment of particulate matter outside the mine considering that emission of dust was taking place only by single source i.e. haul road. This was done to find out the changes in the concentration levels of particulate matter outside the mine from the different length of haul road at varying depth of the mine. Haul roads of different length are desirable at different depth of the mine. As the depth of the mine is increased, the haul road would be extended to reach the deeper most part of the mine and subsequently it will increase the overall length of the haul road for deeper mines. For this study depth of the mine shown from fig 4.3 to 4.7 were used in the similar manner as it was done for the previous part of the study. At initial depth of the mine, the length of the haul road was less. As the depth of the mine had increased, haul roads were also extended to take out the coal from the mine and haul it to the surface. Due to extension of the haul road, the length of it had increased subsequently. Table 4.3 shows the location and other details of the dust sources used in this part of the study.

Table 4.3: Description of dust sources for study on dispersion of dust from different lengths of haul road of mine 'B'

S. No.	Type of Source	Source Id	X – Coordinate (m)	Y- Coordinate (m)	Length of Haul Road (m)	Emission rate
1.	Line Area	HAULROAD 50	-123.26	-437.94	917	2.13×10^{-3} g/sec-m^2
2.	Line Area	HAULROAD 100	-177.76	-615.58	1604	2.13×10^{-3} g/sec-m^2
3.	Line Area	HAULROAD 150	-135.97	-772.31	2543	2.13×10^{-3} g/sec-m^2
4.	Line Area	HAULROAD 200	-174.33	-880.44	3279	2.13×10^{-3} g/sec-m^2
5.	Line Area	HAULROAD 250	-191.33	-1023.9	4173	2.13×10^{-3} g/sec-m^2

Emission rate for haul roads were calculated in the similar manner as in previous chapter from the equation mentioned in the Table 3.2 for haul road separately. The emission rate of the all the haul road were same as visible in Table 4.3. It depends on the width of the haul road which was same and 10 m for all the haul roads.

4.3 Environmental conditions used for modelling

All most similar set of meteorological data were used as in the previous chapter. There are two set of meteorological data required for providing the environmental conditions to the model. Simulation can only be done properly after providing surface meteorological data and upper air data of the area or mine. These set of data were defined in the Table 3.7 and 3.11.

The only change in the data set as the direction of wind. There are three variations considered for varying depth of the opencast mine vis - a - vis haul road and internal overburden dump. Three directions of wind are easterly, westerly and southerly in nature. Wind rose diagram for all these variations of the wind were shown in figure 4.8, 4.9 and 4.10.

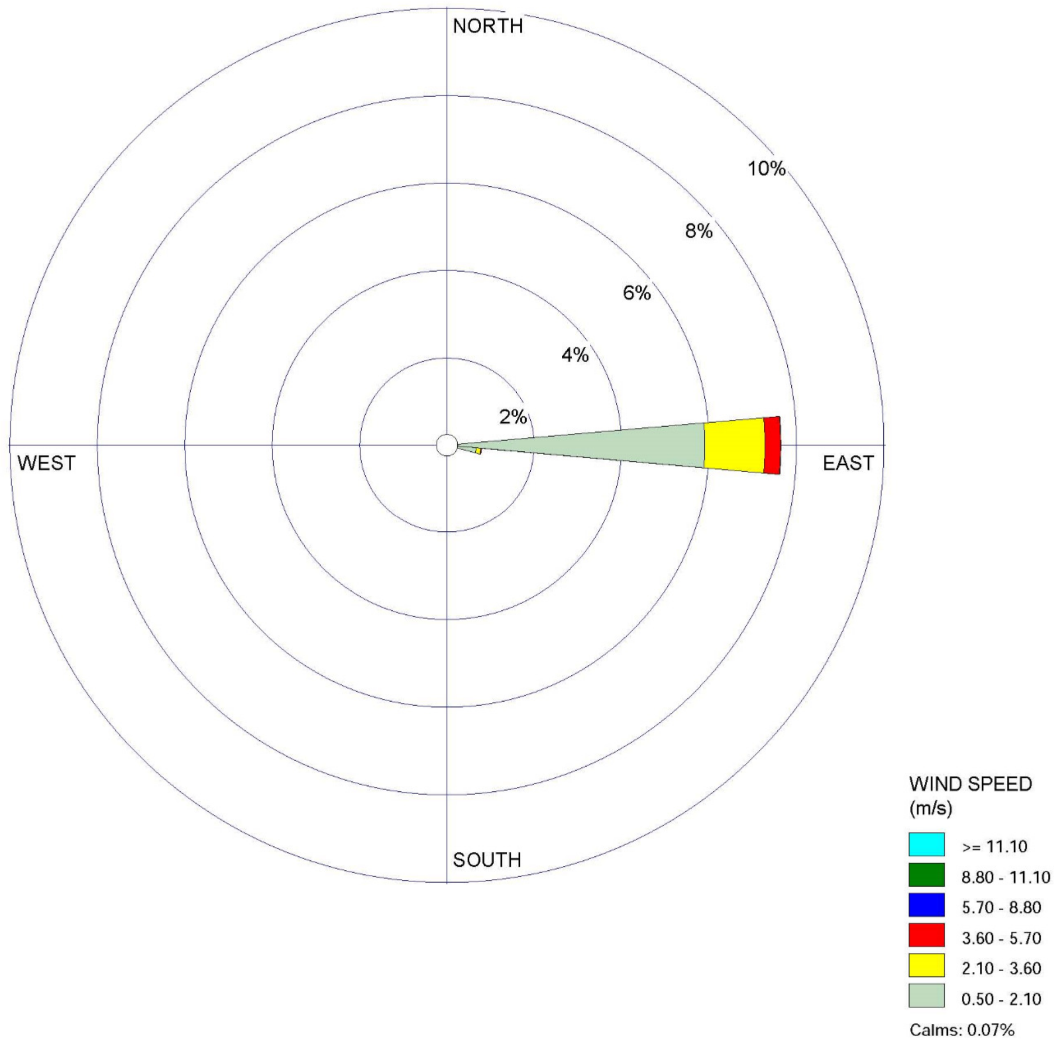


Figure 4.8: Wind - rose diagram of Easterly wind variation

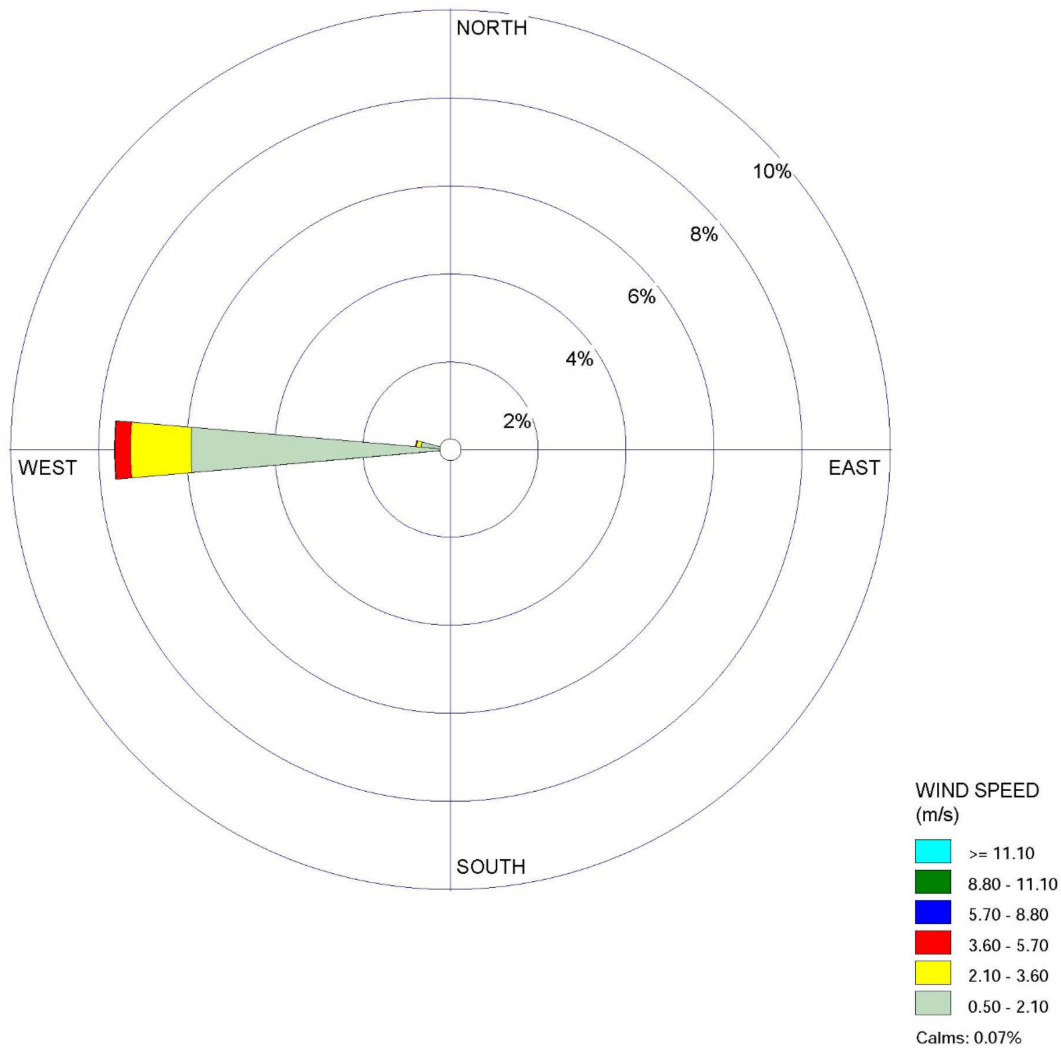


Figure 4.9: Wind - rose diagram of Westerly wind variation

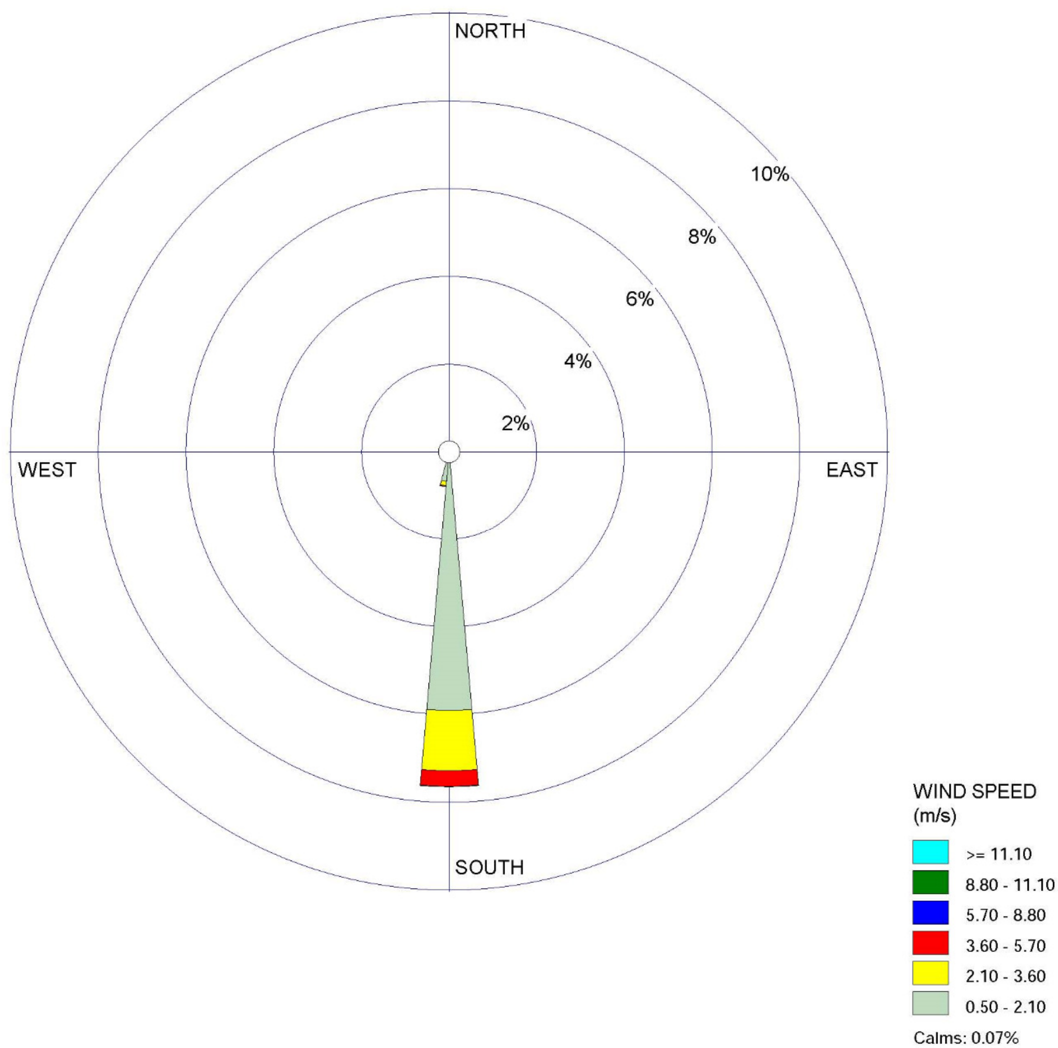


Figure 4.10: Wind - rose diagram of Southerly wind variation