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Noise Modelling in Highly Mechanised Bauxite Mines - A Case Study at Panchpatmali Bauxite Mines of NALCO

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PANCHPATMALI BAUXITE MINE, NALCO

Panchpatmali Bauxite deposit is the one amongst a series of bauxite deposits which were discovered in the east coast region of India in early 1960s to put India in the 5th position in the world's Bauxite map with a total bauxite reserve over 02(two) billion tonnes and current annual production is about 4.8 million tonnes per annum which is now under expansion to 6.3Milion tonne. Considering its vast deposit containing over 300 million tonnes reserve, Panchpatmali bauxite deposit under name and style of NALCO Ltd., was picked up by Govt. of India as a front-runner for the bauxite exploitation in the east cost of India.

Location (Fig-1)

Panchpatmali Bauxite Mines is situated in the district of Koraput, Orissa. The Alumina refinery at Damanjodi is situated at about 16 km from Panchpatmali Bauxite mines. Damanjodi is about 12 km. From Similiguda, a small town located on the national highway no-43, that connects Vijaynagaram of Andrapradesh with Raipur of Madhyapradesh. The Sunabeda Township of Hindustan Aeronautics Limited is 18 km. From Damanjodi. Koraput town, the head quarter of the district is 36 km. from Damanjodi.

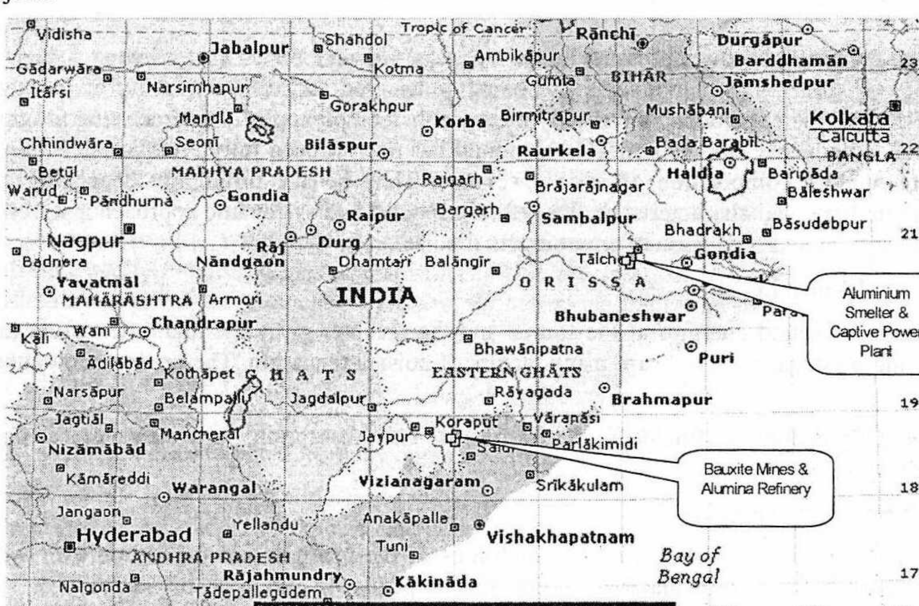


Fig. 1: Locational Map of Different Units of NALCO

Physiography & the Deposit

The Panchpatmali Bauxite deposit is a high level latieritic deposit situated in the Eastern Ghats, an altitude of 1300 mtrs above M.S.L. on a plateau covering 17 Sq.K.M. area. This plateau rises 300M to 400M above the plane of the surrounding hilly terrain of undulating topography.

INTRODUCTION

A number of models were developed and were extensively used for the assessment of sound pressure levels and their attenuation around industrial complexes. The impact of noise in the mining complex depends upon the sound power level of the noise generators, prevailing geo-mining conditions and the meteorological parameters of that complex. To access the noise level in terms of daily noise exposure in such areas is challenging as the sound energy is generated by a number of noise sources simultaneously in a random pattern. The noise levels need to be studied as an integrated effect of various activities, their working environments, geo-mining parameters and the prevailing geographic and meteorological parameters. In the mining condition the equipment locations and environment continuously changes as the mining activity progress. Depending on their placement, the overall noise emanating from the mine varies in quality and level. Thus for environmental noise prediction purpose, he noise level at any receiver point need to be the resultant sound pressure level of all the noise sources.

DEVELOPMENT OF A NOISE MODEL

The basic features of the models developed by different researchers are:

1. Determine the source power levels, $L_{w.}$
2. Compute total atmospheric attenuation for a given environment scenario by calculating the individual attenuation components k_j as follows:
   - Enclosure
   - Barrier
   - Air Absorption
   - Geometric Spreading
   - Wind and Temperature Gradient
   - Ground Effect
   - Shielding by Vegetation
3. Compute the resultant sound pressure level

The number of attenuation components (k_J) being considered and the complexity of the algorithm used to determine the components invariably measure the complexity of the forecasting program. For some of the components, the theoretical background has not yet been fully established. Mining noise sources are random composition of various sources. They behave differently depending on their mobility, periodicity and characteristics. Therefore, a careful and systematic approach is necessary for reliable assessment and prediction of environmental noise.

Attenuation of Noise Level

The difference of sound energies at the source and the receiver gives the total attenuation of sound energy during propagation. There are many factors of noise attenuation. The predominant attenuation factors are:

1. Geometric Spreading; 2. Enclosure; 3. Barrier; 4. Air Absorption; 5. Meteorological Category; 6. Ground Cover

Geometric Spreading(Fig. 2)

Over a distance, there are changes in the conditions of the medium and the terrain over which the sound wave propagates. Attenuation of spreading depends on the type of source. For spherical radiation from a point source, attenuation of 6-dB (A) per doubling of distance from the source is envisaged. It has been seen that for a dipole line source such attenuation is 6-dB (A) per doubling of distance near the source. It is 3-dB (A) in an intermediate zone. At a large distance, this attenuation is again 6-dB (A) per doubling the distance. If a source is located very close to the ground, there occurs an attenuation of 12 -dB (A) for every doubling of source – receiver distance when the receiver is at a considerable distance from the source. For spherical divergence, however, an attenuation of 6-dB (A) is observed. Thus, effects of ground absorption and distance are to be considered together.

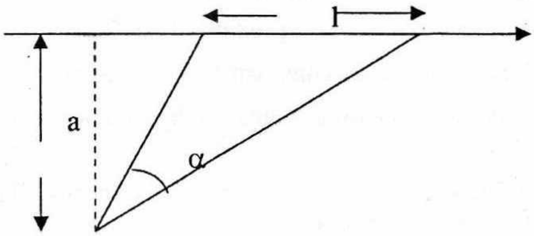


Fig. 2: Geometry for Determination of Line Source Algorithm

The behaviour of attenuation by spreading is also affected by the nature of the source. All sources are to be considered firstly in the absence of the ground i.e. as if they were suspended in free space. For geometric spreading, following considerations are taken into account in the model.

For **point sources**, the attenuation due to geometric spreading is that for spherical radiation:

$$K_l \text{ (point)} = 10 \log (4\pi d^2) \tag{1}$$

Where, d-the distance between source and receiver

For the **line sources** the attenuation for monopole radiation of a source of length (l):

$$K_l \text{ (line)} = 10 \log (4\pi\, al/\alpha) \tag{2}$$

Where, l- the source length.

a -perpendicular separation of the receiver from the line source axis
α - Subtended angle in radians.

In this model, however, all the sources are assumed to be point sources. The conveyor network is ideally suited to be representative of line source. Due to complexity and non-availability of data the same was also not considered here.

Enclosure

A common approach is to consider the interior treatment of a room with sound absorbing material to produce desirable listening conditions. Another important aspect of sound control deals with keeping sounds from directly entering or leaving the room. This requires that the walls, floors, and ceiling have desirable sound transmission characteristics. By definition, the sound transmission loss (STL) of a partition is:

$$STL = 10 \log (I_l / I_t) \text{ dB (A)} \tag{3}$$

Where, I_i - sound intensity incident on one surface of the partition in watts per square meter
I_t - sound intensity radiated from the opposite surface of the partition in watts per square meter.

If the partition is a rigid barrier with air on either side, it can be shown that the sound transmission loss is described by what is called the field incidence mass law.

$$STL = 20 \log w.f. - 47.4 \tag{4}$$

Where, w- area density of the barrier, Kg/m^2
f- frequency of the sound wave, Hz

The ENM program allows sources to be enclosed. Enclosures are defined as a collection of rectangular surfaces with an absorptive face on the side nearest the source and having a sound transmission loss. The total power level of all sources within the enclosure is first determined. The total sound pressure level inside the enclosure and close to the surface is

$$L_{p\ inside} = L_{w\ total} + 10 \log \{Q/(4\pi R^2) + 4/(Abs)\} \quad (5)$$

Where, $Q/(4\pi R^2)$ - the direct field term and is approximately the

reciprocal of the sum of all the surface areas comprising the enclosure.

Abs - the total absorption within the enclosure is obtained by summing the absorption of all enclosure surfaces comprising the enclosure.

Assuming that the sound within the enclosure is mostly reverberant, the sound power "emitted" through each enclosure surface to a free field outside is

$$L_{w\ surface} = L_{p\ inside} - 6 + 10 \log A - 11 \quad (6)$$

In this model the attenuation due to enclosure has been accounted while assessing sound power being emitted from the sources.

Barrier (Fig-3)

Presence of a barrier within the source and the receiver modifies the noise field over a region. The barrier modifies the noise field towards the source by sending reflected waves. The edges of the barrier cause diffraction of sound waves towards the receiver. The diffraction may result in the formation of a shadow zone. Thus the position of the source and the receiver with respect to the barriers is an important factor in assessing industrial noise. Maekawa (1962,1968) developed a chart for calculating the barrier attenuation as a function of the Fresnel number (N), as shown below:

$$N = \pm(\text{Path length difference})/(\lambda/2) \quad (7)$$

$$N = \pm(a + t + b - d)/(\lambda/2)$$

Where, λ- Acoustic wavelength in meter, for the band centre frequency
a - distance from the source to the edge of barrier, m
b - distance from the receiver to the edge of barrier, m
d - the straight line distance from to the source to the receiver, m
t - the thickness of the barrier, m.

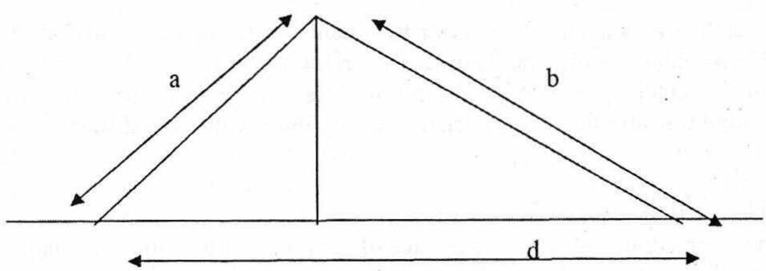


Fig. 3: Barrier Attenuation

The various conditions for noise attenuation due to barriers are given in equations as follows:

$$-0.30 \leq N < -0.02, \qquad K_3 = 5.65 + 66N + 244N^2 + 287N^3$$

$$-0.02 \leq N < 1.0, \qquad K_3 = 5.02 + 21.1N - 19.9N^2 + 6.69N^3 \quad (8)$$

$1.0 \leq N < 18.0 \qquad K_3 = 10 \log N + 18$

$N \geq 18.0 \qquad K_3 = 25$

These formulas are used in the model for calculation of attenuation due to barrier. In the model the barrier is taken as negligible width due to the uneven shape of the barrier and for complexity of calculation of distance from source to receiver.

The minus sign with K_3 is used if the receiver is above the shadow zone of a barrier. Attenuation due to barrier is a combination of ground absorption and loss due to the insertion of a screen.

Air Absorption

The loss of sound energy during its propagation through the atmosphere is well established. This loss is due to a relaxation process. Temperature and humidity significantly influence such loss. Moreover, the degree of attenuation depends on the propagated wave. It was established that frequency and humidity affect attenuation per meter as per the following equation:

$$\alpha_a = k f^2 + \alpha_h \tag{9}$$

Where, α_a - attenuation per meter

k-constant given as, $k = 14.24 * 10^{-11}$

f - frequency, Hz

α_h - humidity dependent factor.

Typical values are 3-dB (A) per 100 meter at 4000 Hz to 0.3-dB (A) per 100 meter at 1000 Hz. This formula is used in the model for calculation of air absorption.

Fog and smoke particles cause additional attenuation. It has been observed that fog particles are less significant for frequencies above 300 Hz. Generally, background noise level decreases with the presence of fog or snow resulting in less masking and sound can be distinguished at lower intensities even at a greater distance.

Meteorological Conditions(Table-2)

Meteorological conditions of the atmosphere influence propagation of sound. Studies reveal that for environmental noise prediction purposes the following meteorological conditions need to be considered:

1. Viscosity; 2.Rain and Fog 3. Wind 4. Humidity 5. Temperature 6. Turbulence

Table 2: Determination of Pasquill Stability Category From Meteorological Information

Wind speed in m/s	Day time incoming solar radiation in mW/cm^2				1 hour before sunset or sunrise	Night time cloud cover in Octas		
	> 60	30-60	< 30	O'cast		0 - 3	4 - 7	> 8
<=1.5	A	A - B	B	C	D	F - G	F	D
2.0 - 2.5	A - B	B	C	C	D	F	E	D
3.0 - 4.5	B	B - C	C	C	D	E	D	D
5.0 - 6.0	C	C - D	D	D	D	D	D	D
> 6.0	D	D	D	D	D	D	D	D

This is the perhaps the most difficult of all algorithms to formulate as the theory is not well understood at present. The two principal meteorological variables are wind and vertical temperature gradient (a positive gradient is called temperature inversion, zero gradient is neutral and a negative gradient is termed lapse rate). In the calculation of attenuation due to meteorological category in the model, the wind and temperature gradient are used.

Acoustic velocity is a velocity relative to air velocity. In the presence of wind, the wind velocity needs to be added to the acoustic velocity to obtain the latter with respect to the ground. Generally, wind velocity is much smaller than the velocity of acoustic wave. Wind increases the background noise level by inducing vibrations to many items in the environment like leaves, lighter structures, etc. A wave is transmitted in such a way that the direction of propagation at any point is always at right angles to the wave front at that point. So the distortion in the wave front due to variation in the velocity leads to a deflection of the direction of propagation. In the downwind direction the sound is deflected downwards and the reverse is the case in the upwind direction. This may induce a shadow zone in the upwind direction. The above effects on transmission are negligible in the near field. In the far field, their influences are significant. Normally, wind speed increases with height over the ground depending on the season. Sound rays travelling in air bend downward in the wind direction and upwards against the wind.

Air temperature varies with altitude. This variation induces an acoustic shadow zone. Acoustic velocity is proportional to the square root of temperature. Temperature decreases with height and therefore the velocity of sound also decreases with height. Thus, the path of sound becomes curved instead of straight in the presence of a temperature gradient in the medium. The radius of curvature of the path at any point is inversely proportional to the velocity gradient at this point. With the temperature decreasing upward (daytime), sound rays will be refracted upwards. This phenomenon results in the formation of a shadow zone. At night, inversion of temperature gradient causes sound rays to bend downwards. With no ground absorption and obstruction the intensity distribution would be the same as the unperturbed one. The inversion of the temperature gradient causes sound to propagate to a larger distance during the night.

The temperature gradient is coded in terms of a Pasquill Stability category A-G as shown in Table 2. Category A represents a strong lapse condition, where category G represents a temperature inversion as may be found on a calm straight night. The vertical temperature gradient so categorised is then combined with the magnitude of the wind vector measured at ground level (i.e. the proportion of the wind vector pointing from source to receiver) using Table 2 and 3. The wind direction is always defined as the component in the direction to or from the source. Crosswind components are ignored. If the wind speed is entered without the wind direction, the programme uses the worst case scenario. This results in one of the six meteorological categories for which attenuation is obtained from the following equations assuming low frequency dominant noise situations in the concerned mining complex:

Table 3: Determination of Meteorological Category

Meteorological category	Pasquill Stability Category		
	A,B	**C,D,E**	**F,G**
1	$V < -3.0$	--------	-------
2	$-3.0 < V < -0.5$	$V < -3.0$	--------
3	$-0.5 < V < +0.5$	$-3.0 < V < -0.5$	$V < -3.0$
4	$+0.5 < V < +3$	$-0.5 < V < +0.5$	$-3.0 < V < -0.5$
5	$V > +3$	$+0.5 < V < +3$	$-0.5 < V < +0.5$
6		$V > +3$	$+0.5 < V < +3$

Meteorological Category 1

$$K_{category1} = (1.20\times10^{-13})\, d^5 - (3.45 \times 10^{-10})\, d^4 + (4.15 \times 10^{-7})\, d^3 - (2.45 \times 10^{-5})\, d^2 + (8.21 \times 10^{-2})\, d - 5. \quad (10)$$

Meteorological Category 2

$$K_{category2} = (9.37 \times 10^{-14})\, d^5 - (3.29 \times 10^{-10})\, d^4 + (4.43 \times 10^{-7})\, d^3 - (2.85 \times 10^{-5})\, d^2 + (8.81 \times 10^{-2})\, d - 3.59 \quad (11)$$

Meteorological Category 3

$$K_{category3} = (7.51 \times 10^{-14})\, d^5 - (2.49 \times 10^{-10})\, d^4 + (3.2 \times 10^{-7})\, d^3 - (1.99 \times 10^{-4})\, d^2 + (5.99 \times 10^{-2})\, d - 3.26 \quad (12)$$

Meteorological Category 4

$$K_{category4} = 0 \quad (13)$$

Meteorological Category 5

$$K_{category5} = (7.58 \times 10^{-9})\, d^3 + (1.70 \times 10^{-5})\, d^2 - (1.48 \times 10^{-4})\, d - 0.22 \quad (14)$$

Meteorological Category 6

$$K_{category6} = (-1.04 \times 10^{-14})\, d^5 + (6.37 \times 10^{-11})\, d^4 - (1.24 \times 10^{-7})\, d^3 - (1.10 \times 10^{-4})\, d^2 - (4.89 \times 10^{-2})\, d - 3.28 \quad (15)$$

Ground Effects

Presence of reflecting surfaces and ground surface influences the overall noise field considerably. Complex reflecting surfaces induce more difficulties in modelling the noise field. Calculation of ground absorption in terms of ground impedance is an established practice. Sutherland (1994) developed a new model for determination of acoustic impedance of ground under grass surfaces. However the basis of this modelling still remains the flow resistivity of the ground surface. The objective of assessing ground absorption is to evaluate the excess attenuation of sound energy propagating over it. This excess attenuation due to ground surface depends on source and receiver heights above the ground surface. The attenuation also depends on the frequency content of the sound. The frequency of maximum ground attenuation is given as:

$$f_{max} = 1500/\{h \log (d/0.3)\} \quad (16)$$

Where, h- mean height of source to receiver path, m.

d- distance between the source and the receiver, m.

The attenuation due to ground absorption has a peak value at f_{max}. The value of f_{max} reduces with an increase in distance and mean height of the propagation path. The attenuation in the octave band containing f_{max} is obtained as:

$$K6 = 15 \log (0.065\, d / h) \quad (17)$$

If $0.065dh^{-1}$ is less than 1, K6 = 0.

This formula is used in the model. In the two octave bands adjacent to that of maximum attenuation, the attenuation is half of the maximum value; in all other cases it is zero. In the presence of a barrier, allowances for the ground absorption is not necessary.

Conceptual Flow Chart of the Model

Based on the above considerations, the conceptual flow charts of the model are developed. Fig 4 represents the conceptual system flow chart in precise form. Besides this, there are five other flow charts (Figures 5 to 9) to cover five attenuation components. Accordingly, the programming of the model is written in C++.

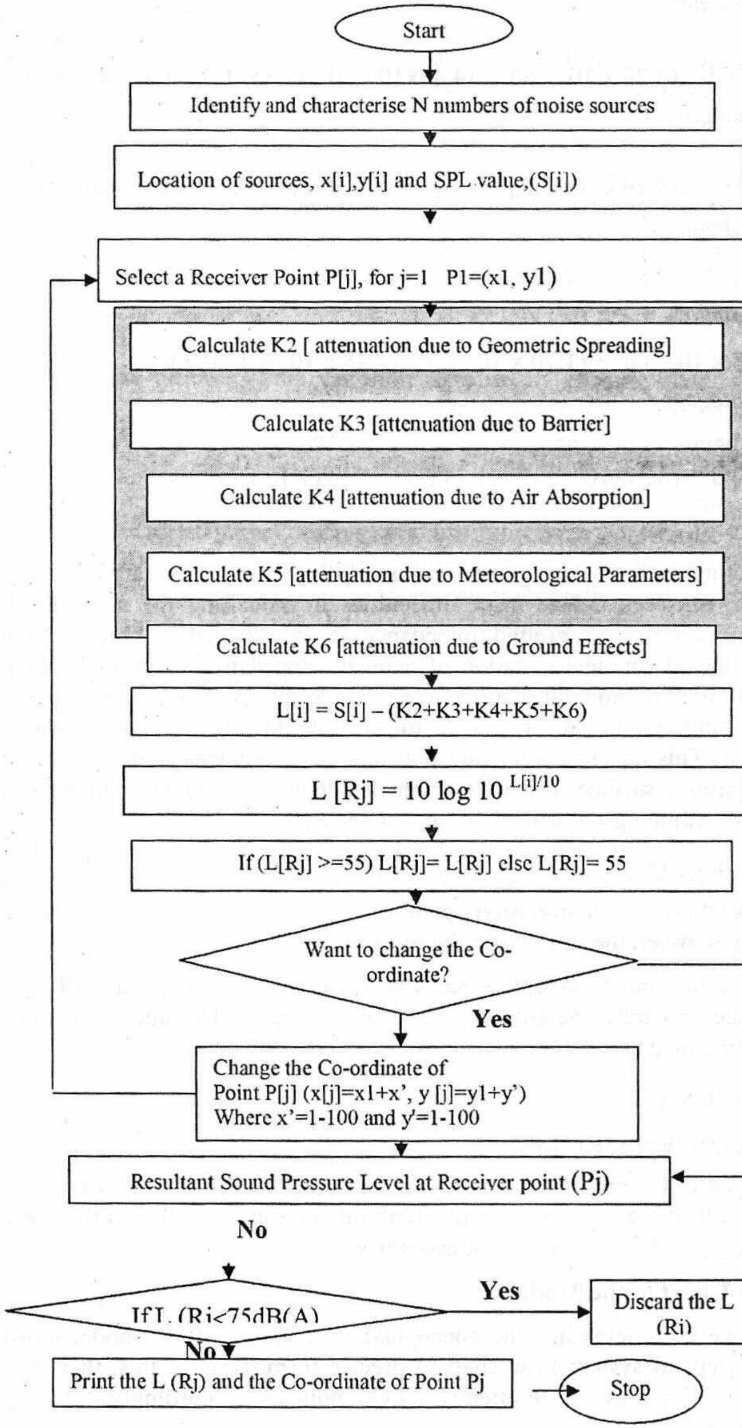


Fig. 4: Conceptual Flow Chart of the Model

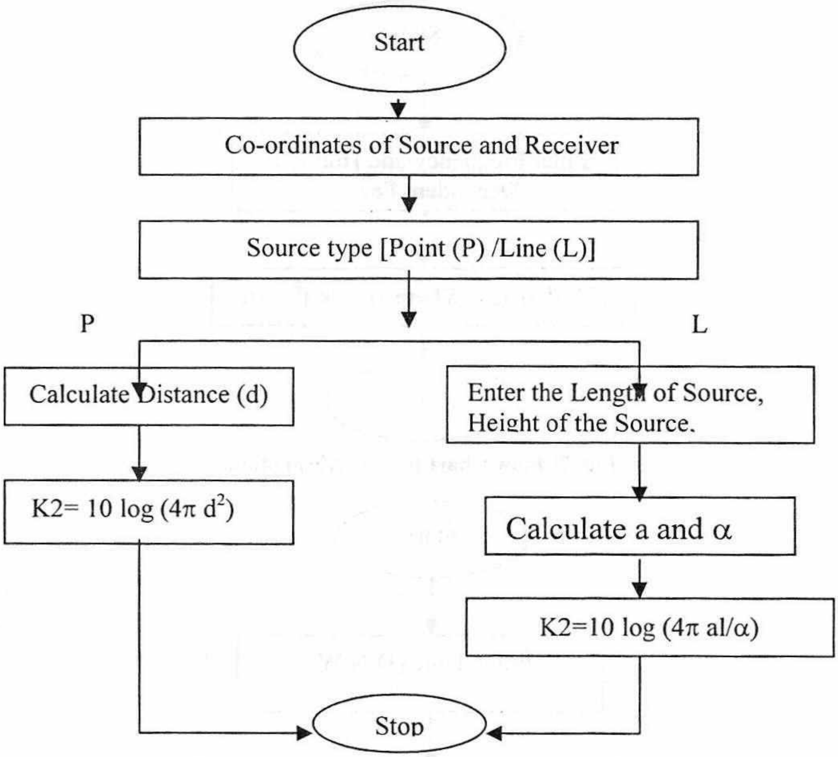


Fig. 5: Flow Chart- for Geometric Spreading

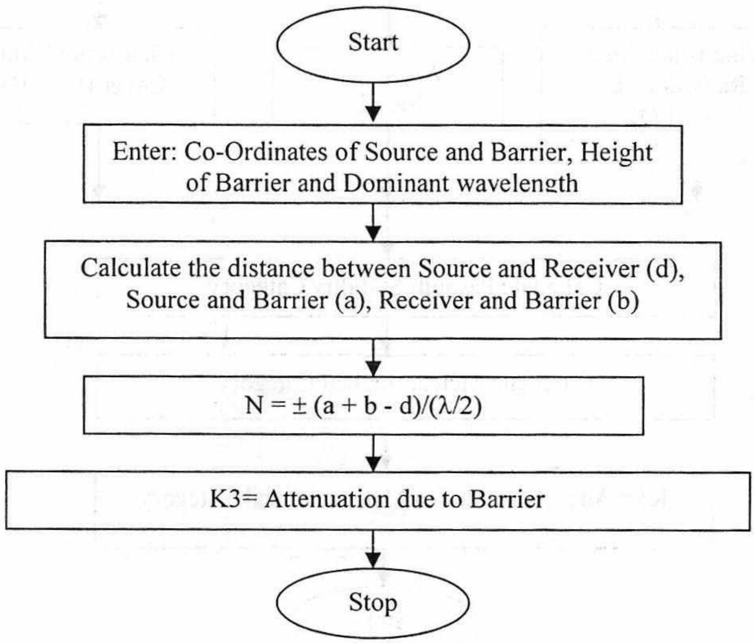


Fig. 6: Flow Chart -For Barrier Attenuation

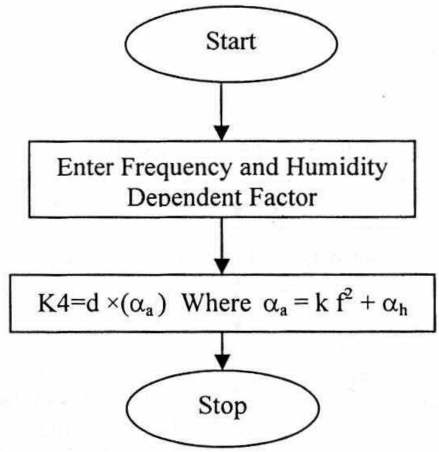


Fig. 7: Flow Chart for Air Absorption

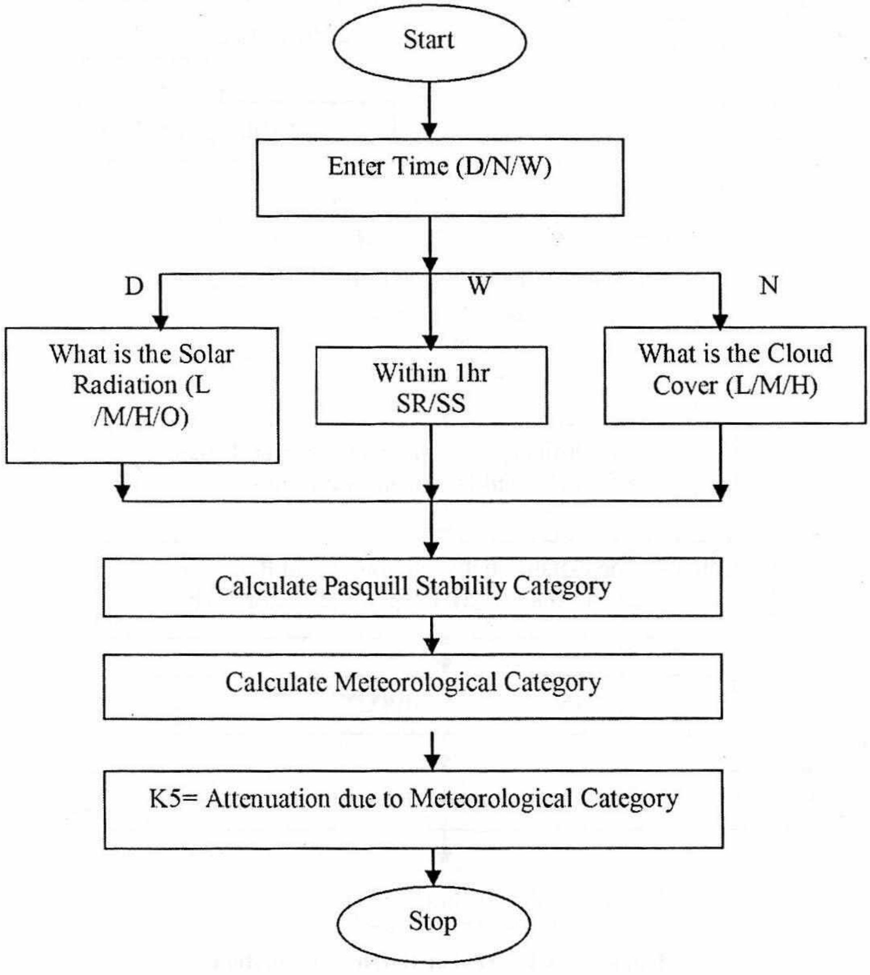


Fig. 8: Flow Chart - for Meteorological Category

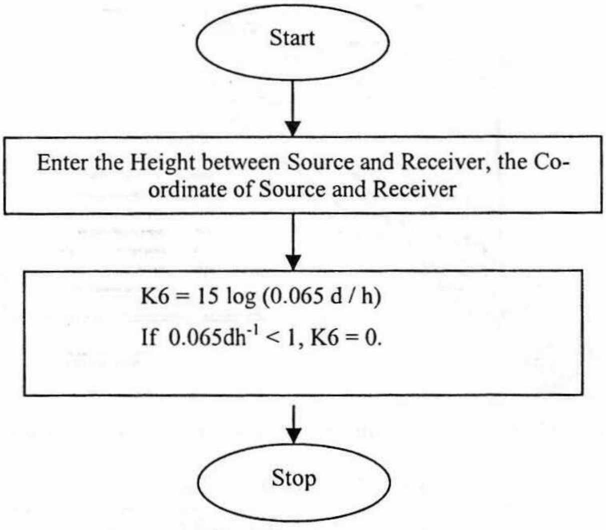


Fig. 9: Flow Chart for Ground Effect

TEST AND VALIDATION OF THE MODEL

Noise database for mine working at Panchapatmali bauxite mine and auxiliary facilities of mine was developed for the realistic evaluation of different mathematical expressions that framed the noise model.

Noise Data Generation for the Model

From preliminary investigations, the major noise sources were identified and plotted in the surface layouts of the mine working of Panchapatmali Bauxite Mine and Auxiliary Facilities of the mine (Figures 10 and 11). The entire surface layout of the each case was considered to be in the positive quadrant and accordingly the locations of all the monitoring stations were identified through X and Y co-ordinate system. A systematic noise monitoring including frequency spectrum analysis was conducted to all the noise sources of the above mentioned three situations. The salient features of the noise monitoring results along with the locations of the noise sources are being presented in Table -5.

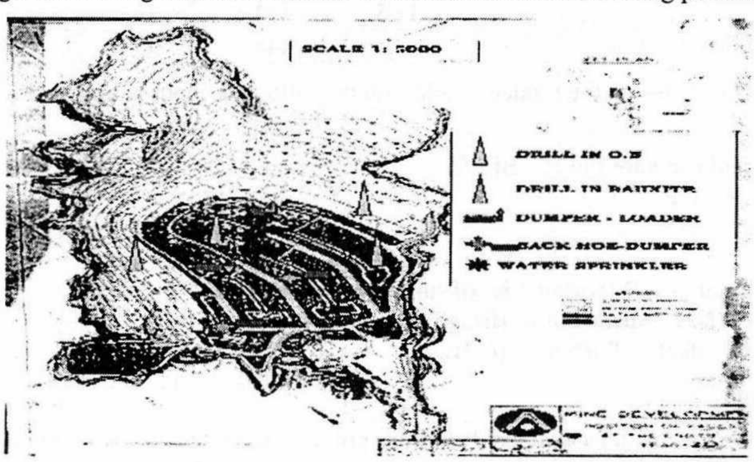


Fig. 10: Mine Working at Panchpatmali Bauxite Mine

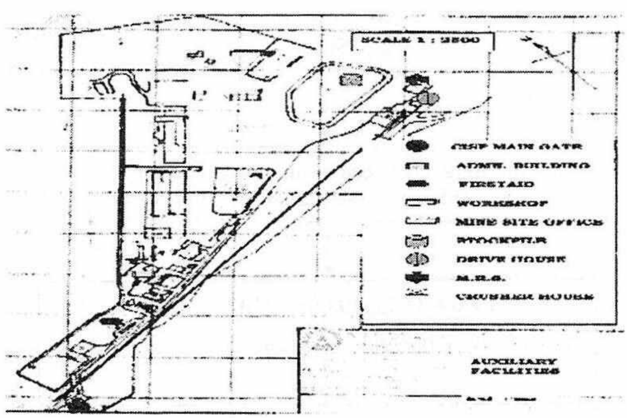


Fig. 11: Auxiliary Facilities at Panchpatmali Bauxite Mine

Table 5: Noise Database

Source	Location (X, Y)		Leq in dB(A)	Dominant Frequency in Hz
	X Co-ordinates in m	Y Co-ordinates in m		
A) mine working at Panchpatmali Bauxite mine				
Drill -1 operation in overburden bench	175	425	94.3	100-160 Hz
Drill -2 operation in overburden bench	440	565	94.3	100-160 Hz
Drill -1 operation in bauxite ore	265	495	95.5	100-160 Hz
Drill -2 operation in bauxite ore	455	450	95.5	100-160 Hz
Dumper-Loader (1) combination	265	425	88.9	31.5-63 Hz
Dumper-Loader (2) combination	325	560	88.9	31.5-63 Hz
Back hoe - dumper (1) combination	275	290	87.3	63-250 Hz
Back hoe - dumper (1) combination	350	400	87.3	63-250 Hz
B) Auxiliary facilities at Panchpatmali Bauxite mine				
Crusher House	355	405	86.3	125-250 Hz
Workshop	137.5	392.5	85.3	125 Hz -2 kHz
Stockpile (dozer in operation)	257.5	442.5	95.0	25-40 Hz

This database was used to run the model. In addition the following input parameters were also fed into the computer:

Back Ground Sound Pressure Level? BL: 55
Type of source? (P/L): P
Humidity factor? : 0.05
Wind velocity? : 5
Time ? [D(day)/ N(night)/ W(within 1 hr of sunrise or sunset)] : D
Solar radiation? [L(low)/ M(medium)/ H(high)/O(overcast)] : L
Choice for Ground effect or Barrier? (G/B): G

Computer Output

Computer runs of the model considered various points within the three situations of the mining complex as mentioned above and calculated resultant Leq for each point. The computer output was restricted to print the locations of all the points having resultant Leq equal or above 75-dB (A) as shown in Table- 1 These predicted values represent the actual situation more or less satisfactorily as evident from the comparison between the predicted resultant Leq of some reference points and the monitored values (Table -4).

Table 1: Result of the Computer Run

Location (X,Y)		Resultant Leq, dB(A)	Location (X,Y)		Resultant Leq, dB(A)
X coordinate	Y coordinate		X coordinate	Y coordinate	
A) Mine working at Panchpatmali Bauxite mine			A) Mine working at Panchpatmali Bauxite mine		
173	424	76.20	265	497	78.38
173	425	77.08	266	425	77.85
173	426	76.20	266	493	77.40
174	423	76.20	266	494	81.42
174	424	80.22	266	495	84.45
174	425	83.25	266	496	81.42
174	426	80.22	266	497	77.40
174	427	76.20	267	493	75.33
175	423	77.18	267	494	77.40
175	424	83.25	267	495	78.38
175	425	94.30	267	496	77.40
175	426	83.25	267	497	75.33
175	427	77.18	274	290	76.25
176	423	76.20	275	289	76.25
176	424	80.22	275	290	87.30
176	425	83.25	275	291	76.25
176	426	80.22	276	290	76.25
176	427	76.20	324	560	77.85
177	424	76.20	325	559	77.85
177	425	77.18	325	560	88.90
177	426	76.20	325	561	77.85
263	493	75.33	326	560	77.85
263	494	77.40	349	400	76.25
263	495	78.38	350	399	76.25
263	496	77.40	350	400	87.30
263	497	75.33	350	401	76.25
264	425	77.85	351	400	76.25
264	493	77.40	438	564	76.20
264	494	81.42	439	563	76.20
264	495	84.45	439	564	80.22
264	496	81.42	440	563	77.18
264	497	77.40	440	564	83.25
265	424	77.85	441	563	76.20
265	425	88.90	441	564	80.22
265	426	77.85	442	564	76.20
265	493	78.38	453	448	75.33
265	494	84.45	453	449	77.40

Contd...

Location (X,Y)		**Resultant Leq, dB(A)**	**Location (X,Y)**		**Resultant Leq, dB(A)**
X coordinate	**Y coordinate**		**X coordinate**	**Y coordinate**	
265	495	95.50	453	450	78.38
265	496	84.45	453	451	77.40
453	452	75.33			
454	448	77.40			
454	449	81.42			
454	450	84.45			
454	451	81.42			
454	452	77.40			

B) Auxiliary facility at Panchpatmali Bauxite mine		
X coordinate	**Y coordinate**	**Resultant Leq, dB(A)**
137	392	85.30
137	393	85.30
138	392	85.30
138	393	85.30
255	441	76.90
255	442	77.88
256	440	76.90
256	441	80.92
256	442	83.95
257	440	77.88
257	441	83.95
257	442	95.00
258	440	77.88
258	441	83.95
258	442	95.00
259	440	76.90
259	441	80.92
259	442	83.95
260	441	76.9
260	442	77.88
354	405	75.25

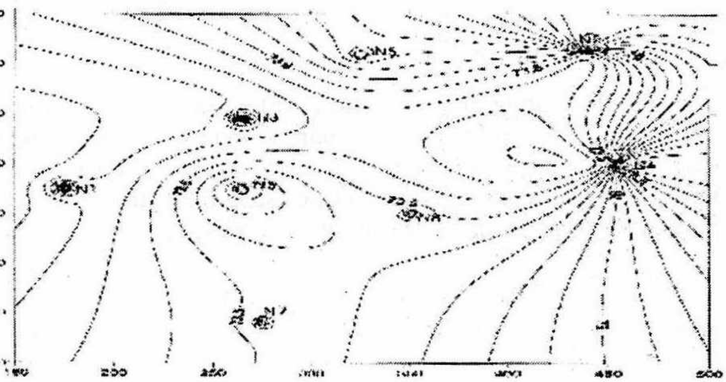
Table 4: Comparison of Field Data and Test Data From the Model

Sl. No	**X Co-ordinate in meter**	**Y Co-ordinate in meter**	**Leq in dB(A) in field condition**	**Leq in dB(A) from the model**
A) Mine working at Panchpatmali Bauxite mine				
1	191	416	55.1	56.0
	225	235	89.6	90.7
	225	380	83.2	84.9
2	280	475	57.2	55.5
3	340	404	58.3	55.2
4	422	560	53.2	55.7

Contd...

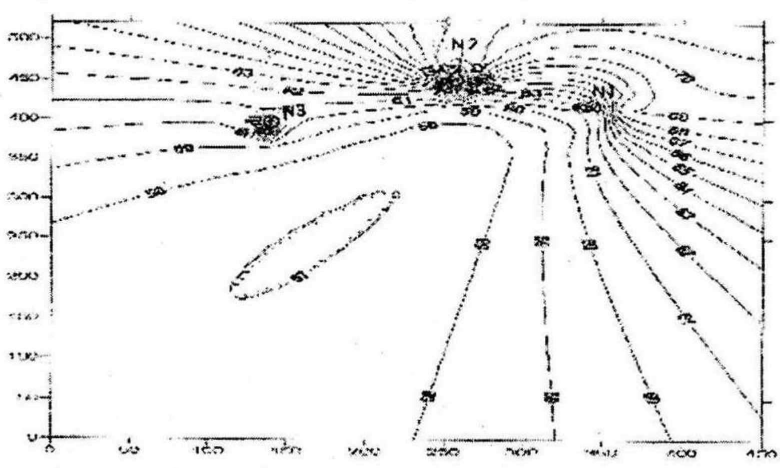
Sl. No	X Co-ordinate in meter	Y Co-ordinate in meter	Leq in dB(A) in field condition	Leq in dB(A) from the model
B) Auxiliary facility at Panchpatmali Bauxite mine				
1	103	185	55.7	55.0
2	250	400	91.8	93.9
3	350	400	57.2	55.0

This computer result was then utilized in the SURFER Package (version 4.14, 1989) to draw the noise contours of the mining complex as presented in Figures.12, 13 and 14. Figures 12 represent the noise profile [≥ 75 dB(A)] for mine workings of Panchpatmali mine. Fig 13, on the other hand, represents the noise profile [≥ 55 dB(A)] for Auxiliary Facilities of the mine. The noise contour profiles give the overall noise situation of the entire mining complex.



Legend:
N1 - Drill-1 (Overburden); N2 - Drill-2 (Overburden)
N3 - Drill-1 (Bauxite ore) ; N4 Drill 2 (Bauxite ore)
N5 - Dumper-Loader 1 ; N6 Dumper-Loader-2
N7 Back Hoe Dumper-1 ; N8 - Back Hoe-Dumper-2

Fig. 12: Noise Profile of Mine Workings at Panchpatmali Bauxite Mine



Legend:
N1 - Crusher House
N2 - Stock pile (dozer in operation)
N3 - Workshop/Maintenance yard

Fig. 13: Noise Profile of Auxiliary Facilities, Panchpatmali Bauxite Mine

LIMITATION OF THE MODEL

The model thus developed needs some refinement as outlined below:

- Directive index needs to be suitably incorporated.
- The concept of line sources needs to be incorporated. The model should have the flexibility to consider any combination of different types of sources.
- The porosity and internal elastic structure of the rock varies widely with type and orientation of the rocks at different stages of mining complex. The coherent research into mining noise has not been considered the nature of acoustic transmission into the rock mass. Future research in this field could lead to the establishment of the relationship between the behaviour of types of rock under mining condition and their impacts on absorption and reflection of sound energy propagating over this.
- Haul roads in mining complex are one of the major noise sources. Further research is necessary to evaluate haul road profiles in terms of their impact on the noise field

CONCLUSION

It is essential for accurate forecasting of noise status (Leq) inside the mining complexes. This model helps us to develop noise contour / profile of the mining complex. As such, it is possible to have an estimate of the expected noise dose of the exposed workers at different locations within the complex. In case of new mine or reorganization / renovation of existing mine, this model helps in equipment / activity planning so as to have minimum noise exposure to the exposed workers.