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Study of Illumination and Designing an Appropriate Layout for Lighting at Various Places in an Underground Coal Mine

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ABSTRACT

Provision of suitable work environment for the workers is essential for achieving higher production and productivity in both surface and underground mines. Poor lighting and noisy working conditions have negative effects on the workers' morale and adversely affects their safety, health and performance. In order to assess the status of illumination and noise levels in mines, systematic illumination and noise surveys are needed to be conducted using appropriate statutory guidelines so that effective control measures can be taken up in mines. Keeping this in view, this project work was undertaken to carry out illumination and noise survey in few noncoal and coal mines of Orissa.

INTRODUCTION

The provision of adequate illumination and the need to ensure a safe visual working environment is a challenge faced by almost all mining industries. Lighting in mines presents special problems because of the dark surroundings and low reflectance. In opencast mines where work is being carried out at night shifts, effective illumination is required to achieve production and safe operation of various machinery at different work areas. Open-cast mines cover a large area and continually change their shape as mining proceeds. Lighting provision is mainly important in the underground coal mining industry as there is no natural light, and large machines operate in a confined, dusty and a potentially explosive environment. Noise that is defined as unwanted sound has been a source of discontent ever since people began living together. The problem has been further aggravated by the rapid industrialization consequent upon technological advancements to meet the ever increasing demand of industrial products. So far as mining industry is concerned, the noise pollution is not new. The introduction of mechanization has undoubtedly accentuated the noise problem. Mining by opencast methods has become most favorable due to its high productivity, economic viability, better safety, higher conservation, etc. The availability of large diameter drills and various types of explosives facilitate use of hundreds of tonnes of explosives to break the overburden rocks as well as coal. In pit crushing system with mobile crusher and large capacity coal handling plants are being installed. All these activities are major sources of noise pollution.

OBJECTIVES

- Understanding of the basic concepts of illumination and noise.
- To measure illuminance level of luminaries using a digital luxmeter in surface and underground coal/non-coal mines.
- To conduct noise survey in few opencast and underground coal/non-coal mines.
- To assess the adequacy of illumination and noise levels in mines vis-à-vis Indian standards.

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ILLUMINATION AND NOISE SURVEY

Illumination survey was carried out at opencast mine of BSL Birmitrapur & Underground Coal Mines of MCL in Orissa, using Digital Luxmeter (Metravi1332).Similarly, noise survey was carried out in opencast mine of BSL Birmitrapur & Underground Coal Mines of MCL in Orissa, using Sound level meter (CEL 283). The results of studies were compared with the existing standards and due inferences were obtained.

ILLUMINATION IN MINES

PHOTOMETRIC TERMINOLOGIES

Light Physics Two major systems of units are currently used for the quantification of light: illumination Engineering society (IES) and international systems of units (SI). The primary difference between IES and SI systems is that the IES system uses US standard measures for linear dimensions .In the unit definitions while the SI system uses metric measures.US coal mine lighting regulations customarily use IES units. All standard systems of light units employ certain fundamental concepts that are based on the convenient and meaningful approaches to light energy measurement and quantification .These basic concepts are luminous flux, illumination (illuminance), luminous intensity, and luminance.

Luminous flux The luminous flux symbol is Ø, and the lumen (lm) is the flux unit n used in both the IES and SI systems. Luminous flux is the time flow rate of light energy. Flux is a power quantity in the same manner as horsepower. The unit of luminous flux, the lumen, is most frequently used to describe the lighting power of light sources.

Lumen (unit) The lumen (symbol: lm) is the SI unit of luminous flux, a measure of the perceived power of light. Luminous flux differs from radiant flux, the measure of the total power of light emitted, in that luminous flux is adjusted to reflect the varying sensitivity of the human eye to different wavelengths of light.

Noise Measuring Instruments

The most common instruments used for measuring noise are the sound level meter (SLM), the integrating sound level meter (ISLM), and the noise dosimeter. It is important that we should understand the calibration, operation and reading the instrument when in use. Table 1 provides some instrument selection guidelines.

Sound Level Meter (SLM)

A Sound level meter is the simplest instrument available to determine noise levels. The meter usually contains the following basic elements: (1) a microphone to sense the sound-wave pressure and convert pressure fluctuations into an electrical voltage, (2) an input amplifier to raise the electrical signal to a usable level, (3) a weighting network to modify the frequency characteristics of the instruments,(4) an output amplifier,(5) a rectifier to determine the rms value, and(6) an indicating instrument to display the measured sound level. The response of the meter and the characteristics of the indicating instrument depend significantly upon whether the instrument is of type 1,2 , or 3.The SLM must be calibrated before and after each use. With most SLMs, the readings can be taken on either SLOW or FAST response. The response rate is the time period over which the instrument averages the sound level before displaying it on the readout. Workplace noise level measurements should be taken on SLOW response. Impulse characteristics and peak-hold features are sometimes provided as special features.

NOISE CONTROL A.

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Generation, Transmission and Reception. Before steps are taken to develop noise control solutions, the problem should be analyzed in terms of; the source of the noise, the pathway of transmission and the receivers being exposed. B. Identify the Source - Frequently, a single piece of mining equipment will combine several individual sources of noise. C. Determine the Transmission Pathways - Sound can be propagated over long distances through structures and noise from individual sources may reach the receiver through different pathways. D. Consider the Receivers - Consider options on the amount of exposure to the noise rather than the noise itself E. Distance Considerations - Sound, which propagates from a point source in free air, attenuates (reduces by) 6 dB for each doubling of the distance from the source. Sound propagating in an enclosed space is attenuated less than this value, because of contributions to the sound level brought about by reflection from walls and ceilings. 45 F. Addition of Noise from Several

RESULTS & DISCUSSION

(A) Illumination Survey From the field survey, it was observed that the illuminance level measured in inclined shafts & travelling roadways conveyance for man riding of Hirakhand Bundia mines were adequate of average illuminance 30 lux of each light source at floor level. Taking into account Indian lighting standards in respect of underground mining travelling roadway lighting should be based on a minimum light level of 0.5 lux, an average light level of 4.0 lux. The roofs and sides were properly white washed and stone dusted on the floor as required under the regulations to achieve illumination to the standards for providing necessary visibility for safe and efficient work at different work places. Travelling roadways were well illuminated with CFL (compact florescent lamps). The Mine personnel tried to compensate for the effect of low height pole by increasing the tilt angle, but this caused the light resulting in glare problems for the mine workers as the lamp came in his vision.

(B) Noise Survey Results of sound pressure levels at Hirakhand Bundia mines are presented in given Table 3.5 and in figure 3.10. An average of five values of noise level of each source was taken. The maximum sound pressure level was found at auxiliary fan are usually suspended in junctions close to ear level. The noise stems from the motor and from air turbulence, mainly at the intake end. Vibration transmitted from the fan housing to the duct and the suspension system radiates as noise. control measures should be adopted like air intakes may be fitted with silencers containing synthetic fiber sound absorption material noise by as much as 11 dB(A). Also, it can be seen from the figure 3.10 the maximum sound pressure level was found at the LHD B7. This is due to the LHD B7 dealing with hard ore moving loaded and unloaded. The major sources of noise in LHDs are the engines, its intake and exhaust, the cooling fan for the engine and the drive train. Control measures should be adopted like controlling engine speed; vibration isolation mounts between transmission and structures. Exhaust fans on surface are the major source of noise in underground mining. Axial flow fans with discharge capacity 2 lakh ft3 /min of air with fan static pressure ranging up to 15 cm of water gauge or more. Moving these large air volumes requires large power input which are ultimately converted to noise because of inefficiencies inherent in any mechanical system. Control measures like provision of inlet and discharge silencers, noise absorbing splitters, replacing worn out parts and planned maintenance should be adopted to reduce the noise levels. Almost all machineries & equipments in this mine produced higher level of noise (>90dB (A)) than the acceptable noise. According to DGMS Circular No.18 (Tech), 1975 a worker should not be allowed to enter, without appropriate ear protection, an area in which the noise level is 115- dB (A) or more.

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CONCLUSIONS

The results obtained from illumination survey in mechanized unit of pathpahar mines of BSL reveal that at loading points, near crushers, mini crushers & dumping yards were adequate and are within the limits of Indian standards whereas illuminance levels in electrical substation, store room, rest rooms and electrical control rooms were inadequate. From the survey results in underground coal mines of MCL, it was found that roadways were comparatively narrow and is not easy to illuminate uniformly because of limited height in underground. The excessive length of roadways in a mine below ground makes it uneconomical to provide lamps at all places; therefore, they are concentrated at places, which are most active i.e. pit bottoms, loading point etc. The illuminance level measured in inclined shafts & travelling roadways conveyance for man riding of Hirakhand Bundia mines were adequate. The illuminance level measured in inclined shafts & travelling roadways in different levels of Nandira colliery, Talchir were fairly satisfactory. From the survey it was observed that most of the underground mines use florescent lights which provide better light distribution, longer lives, higher efficacy, better color concentration, and less glare potential.
Noise has become an integral part of mining environment. Introduction of more and more mechanization, powerful equipment is expected to increase more noise problems thereby inducing noise doses with associated physiological and psychological problems to the exposed populations. Repeated or prolonged exposure to excessive noise levels will lead to hearing impairment. Potential sources of noise emissions include compressors, drilling machines, crushers, or other mechanical equipment used at a mine. Wherever possible, such noise sources should be muffled with an effective acoustic absorbing material so as to reduce noise emissions to tolerable levels. Increasing the distance between the noise source and the listener is often a practical method of noise control. Where such noise control measures are not possible, comfortable and practical personal hearing protection devices, such as approved ear plugs or ear muffs, should be worn by every person exposed to noise levels exceeding 90 dBA

The results obtained indicated that the sound pressure levels of various machineries used in Pathpahar mines of BSL, & underground coal mines of MCL were higher than the acceptable limits (>90dB (A)). In the mines under study, most of the mine workers were exposed to SPL (sound pressure level) beyond TLV (90dBA) due to machinery noise. Therefore, control measures should be adopted in mines for machinery as well as hearing protection aids should be supplied to the workers in order to protect the mine workers from NIHL (Noise induced hearing loss) & to keep the environment safe.

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