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An Investigation of Sinkhole Subsidence and its Preventive Measures in Underground Coal Mining

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Abstract

Subsidence is a depression of the ground on the surface due to extraction of minerals from underground coal mines. It occurs in two forms, namely, trough and sinkhole subsidence. Trough subsidence is a depression covering a large surface area whereas sinkhole subsidence is a localized phenomenon occurring due to sudden collapse of overburden into the underground voids.The impact of sinkhole subsidence on the environment can occasionally be very catastrophic, destroying property and even leading to the loss of life. The environmental components can be defined as public health and safety, social relationships, air and water quality, flora and fauna. The paper discusses the causes and Impact of sinkhole subsidence on various environmental aspects. The paper also highlights the researchers who work on different models for risk assessment of sinkhole subsidence, this has been done by using various methods, namely, empirical, semi-empirical, remote sensing & GIS, numerical method and geophysical method to save human life, environment and prevent the loss to property.

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Keywords: Subsidence; Sinkhole; Environment

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1. Introduction

Several underground coal mines in India are located near urban areas. There is also a growing trend of human occupation near mining sites due to foreseen benefits of employment and lively hood. Sinkhole formation in such locations can be dangerous to life and property as it does not give any prior indication of its occurrence. It causes increased costs, and delays to new development; damage to existing development and infrastructure; and, in the worst cases, injury or loss of life. It may give rise to derelict land, loss of industrial production and loss of homes (Fig. 1). Numerous damaging subsidence events occur each year often because past development has taken place in subsidence prone areas. The economic impact of sinkhole subsidence, in the form of loss of surface and underground property, disruption of work, production loss, cleaning of the sinkhole in affected areas and filling of the sinkhole, is also significant in many cases.

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Fig. 1. Sinkhole Subsidence[1]

Underground excavations created for coal mining purpose may create cavities in the subsurface due to deformations and displacements of the overlying strata, the extent of which depends on the magnitude of the in-situ stresses, mining induced stresses, void size, immediate roof characteristics and presence of geological discontinuities. With time, these cavities may enlarge as remnant pillars left to support immediate roof deteriorate and the superjacent strata moves into the voids, resulting in instability of underground workings[2]. Gradually, these movements work up to the surface to form a depression on the ground surface which is commonly referred to as subsidence (Fig. 2). Surface subsidence generally entails both vertical and lateral ground movements. It manifests in three major ways, namely, cracks, troughs or sag and sinkhole subsidence.

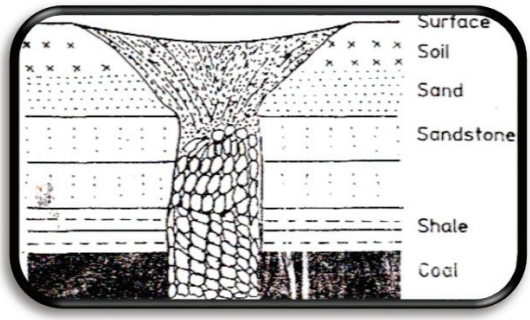

Fig. 2. Formation of Sinkhole Subsidence[3]

In this paper, authors discusses the causes and Impact of sinkhole subsidence on various environmental aspects and also highlights the researchers who work on different models for risk assessment of sinkhole subsidence, that has been done by using various methods, namely, empirical, semi-empirical, remote sensing & GIS, numerical method and geophysical method to save human life, environment and prevent the loss to property. Sinkhole phenomena can be controlled by design of proper stiffness supports, construction of wall, Grouting of voids, Areal backfilling and Fillings of crack.

2. Factors affecting sinkhole subsidence

The sinkhole subsidence occurs depends upon various factors. The main factors which are governing for sinkhole subsidence are method of working, multiple working seam and depth of extraction, thickness of seam, presence of geological disturbances, in situ stresses, surface topography, nature of overburden, lowering of ground water, rainfall and earthquakes. Brief descriptions of each important factor are given below:

2.1. Method of working

Bord-and-pillar, longwall, and in situ extraction techniques will affect the surrounding rock differently; pillar layout, cavity shape and the volume of material removed govern the timing and configuration of surface expressions. For example, longwall mining generally produces