UNDERGROUND MINING METHODS

CHOICE OF METHODS

By

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Underground Mining Methods:

The goal of coal mining is to obtain coal from the ground. Coal is valued for its energy content, and, since the 1880s, has been widely used to generate electricity. Steel and cement industries use coal as a fuel for extraction of iron from iron ore and for cement production. In the United States, United Kingdom, and South Africa, a coal mine and its structures are a colliery. In Australia, colliery generally refers to an underground coal mine.

Coal mining has had many developments over the recent years, from the early days of men tunneling, digging and manually extracting the coal on carts, to large open cut and long wall mines. Mining at this scale requires the use of draglines, trucks, conveyors, jacks and shearers.

Choice of Methods.

The most economical method of coal extraction from coal seams depends on the depth and quality of the seams, and the geology and environmental factors. Coal mining processes are differentiated by whether they operate on the surface or underground. Many coals extracted from both surface and underground mines require washing in a coal preparation plant. Technical and economic feasibility are evaluated based on the following: regional geological conditions overburden characteristics; coal seam continuity, thickness, structure, quality, and depth; strength of materials above and below the seam for roof and floor conditions; topography (especially altitude and slope); climate; land ownership as it affects the availability of land for mining and access; surface drainage patterns; ground water conditions; availability of labor and materials; coal purchaser requirements in terms of tonnage, quality, and destination; and capital investment requirements.

Surface mining and deep underground mining are the two basic methods of mining. The choice of mining method depends primarily on depth of burial, density of the overburden and thickness of the coal seam. Seams relatively close to the surface, at depths less than approximately 180 ft (50 m), are usually surface mined.

Coal that occurs at depths of 180 to 300 ft (50 to 100 m) are usually deep mined, but in some cases surface mining techniques can be used. For example, some western U.S. coal that occur at depths in excess of 200 ft (60 m) are mined by the open pit methods, due to thickness of the seam 60-90 feet (20-30 m). Coals occurring below 300 ft (100 m) are usually deep mined. However, there are open pit mining operations working on coal seams up to 1000-1500 feet (300-450 m) below ground level, for instance Tagebau Hambach in Germany.

The two principal methods of underground working are pillar and stall (stoop/board and room in) and longwall, all other systems in vogue being simply modifications or combinations of these two systems. .{You are reading it on mineportal.in}The method of working any seam naturally depends on local circumstances in each individual colliery. Speaking generally, the system adopted varies according to the thickness of the coal. Seams of 4 ft. and upwards are usually worked by the bord and pillar method ; and seams having a thickness of less than 4 ft. are usually worked by longwall. There are, however, exceptions to this ; some seams above 4 ft. thick being worked by longwall, while, on the other hand, certain seams below 4 ft. are worked by bord and pillar. Besides the thickness of the seam, the mode of working will depend on other circumstances, such as :

a) The inclination of the strata and the nature of roof and pavement.
b) The depth of the seam from the surface.
c) The chemical and physical properties of the coal.
d) The natural cleavage of the coal and that of the rocks forming the roof.
e) The presence or absence of water.
f) The vicinity of other seams or of other workings which should not be interfered with.
g) The number of dykes and dislocations in the field to be worked.

Modern surface mining

When coal seams are near the surface, it may be economical to extract the coal using open cut (also referred to as open cast, open pit, or strip) mining methods. Open cast coal mining recovers a greater proportion of the coal deposit than underground methods, as more of the coal seams in the strata may be exploited. Large open cast mines can cover an area of many square kilometers and use very large pieces of equipment. This equipment can include the following: Draglines which operate by removing the overburden, power shovels, large trucks in which transport overburden and coal, bucket wheel excavators, and conveyors. In this mining method, explosives are first used in order to break through the surface, or overburden, of the mining area. The overburden is then removed by draglines or by shovel and truck. Once the coal seam is exposed, it is drilled, fractured and thoroughly mined in strips. The coal is then loaded on to large trucks or conveyors for transport to either the coal preparation plant or directly to where it will be used.

Most open cast mines in the United States extract bituminous coal. In Canada (BC), Australia and South Africa, open cast mining is used for both thermal and metallurgical coals. In New South Wales open casting for steam coal and anthracite is practised. Surface mining accounts for around 80 percent of production in Australia, while in the US it is used for about 67 percent of production. Globally, about 40 percent of coal production involves surface mining.

Strip mining

Strip mining exposes coal by removing earth above each coal seam. This earth is referred to as overburden and is removed in long strips. The overburden from the first strip is deposited in an area outside the planned mining area and referred to as out-of-pit dumping. Overburden from subsequent strips are deposited in the void left from mining the coal and overburden from the previous strip. This is referred to as in-pit dumping.

It is often necessary to fragment the overburden by use of explosives. This is accomplished by drilling holes into the overburden, filling the holes with explosives, and detonating the explosive. The overburden is then removed, using large earth-moving equipment, such as draglines, shovel and trucks, excavator and trucks, or bucket-wheels and conveyors. This overburden is put into the previously mined (and now empty) strip. When all the overburden is removed, the underlying coal seam will be exposed (a block of coal). This block of coal may be drilled and blasted (if hard) or otherwise loaded onto trucks or conveyors for transport to the coal preparation (or wash) plant. Once this strip is empty of coal, the process is repeated with a new strip being created next to it. This method is most suitable for areas with flat terrain.

Equipment to be used depends on geological conditions. For example, to remove overburden that is loose or unconsolidated, a bucket wheel excavator might be the most productive. The life of some area mines may be more than 50 years.

Contour mining

The contour mining method consists of removing overburden from the seam in a pattern following the contours along a ridge or around the hillside. This method is most commonly used in areas with rolling to steep terrain. It was once common to deposit the spoil on the downslope side of the bench thus created, but this method of spoil disposal consumed much additional land and created severe landslide and erosion problems. To alleviate these problems, a variety of methods were devised to use freshly cut overburden to refill mined-out areas. These haul-back or lateral movement methods generally consist of an initial cut with the spoil deposited downslope or at some other site and spoil from the second cut refilling the first. A ridge of undisturbed natural material 15 to 20 ft (5-6 m) wide is often intentionally left at the outer edge of the mined area. This barrier adds stability to the reclaimed slope by preventing spoil from slumping or sliding downhill.

The limitations of contour strip mining are both economic and technical. When the operation reaches a predetermined stripping ratio (tons of overburden/tons of coal), it is not profitable to continue. Depending on the equipment available, it may not be technically feasible to exceed a certain height of highwall. At this point, it is possible to produce more coal with the augering method in which spiral drills bore tunnels

into a highwall laterally from the bench to extract coal without removing the overburden.

Mountaintop removal mining

Mountaintop coal mining is a surface mining practice involving removal of mountaintops to expose coal seams, and disposing of associated mining overburden in adjacent valley fills. Valley fills occur in steep terrain where there are limited disposal alternatives.

Mountaintop removal combines area and contour strip mining methods. In areas with rolling or steep terrain with a coal seam occurring near the top of a ridge or hill, the entire top is removed in a series of parallel cuts. Overburden is deposited in nearby valleys and hollows. This method usually leaves ridge and hill tops as flattened plateaus. The process is highly controversial for the drastic changes in topography, the practice of creating head-of-hollow-fills, or filling in valleys with mining debris, and for covering streams and disrupting ecosystems.

Spoil is placed at the head of a narrow, steep-sided valley or hollow. In preparation for filling this area, vegetation and soil are removed and a rock drain constructed down the middle of the area to be filled, where a natural drainage course previously existed. When the fill is completed, this underdrain will form a continuous water runoff system from the upper end of the valley to the lower end of the fill. Typical head-of-hollow fills are graded and terraced to create permanently stable slopes.

Underground mining

Most coal seams are too deep underground for opencast mining and require underground mining, a method that currently accounts for about 60 percent of world coal production. In deep mining, the room and pillar or bord and pillar method progresses along the seam, while pillars and timber are left standing to support the mine roof. Once room and pillar mines have been developed to a stopping point (limited by geology, ventilation, or economics), a supplementary version of room and pillar mining, termed second mining or retreat mining, is commonly started. Miners remove the coal in the pillars, thereby recovering as much coal from the coal seam as possible. A work area involved in pillar extraction is called a pillar section.

Modern pillar sections use remote-controlled equipment, including large hydraulic mobile roof-supports, which can prevent cave-ins until the miners and their equipment have left a work area. The mobile roof supports are similar to a large dining-room table, but with hydraulic jacks for legs. After the large pillars of coal have been mined away, the mobile roof supports legs shorten and it is withdrawn to a safe area. The mine roof typically collapses once the mobile roof supports leave an area.

THERE ARE SIX PRINCIPAL METHODS OF UNDERGROUND MINING:

LONGWALL MINING accounts for about 50 percent of underground production. The longwall shearer has a face of 1,000 feet (300 m) or more. It is a sophisticated machine with a rotating drum that moves mechanically back and forth across a wide coal seam. .{You are reading it on mineportal.in}The loosened coal falls on to a pan line that takes the coal to the conveyor belt for removal from the work area. Longwall systems have their own hydraulic roof supports which advance with the machine as mining progresses. As the longwall mining equipment moves forward, overlying rock that is no longer supported by coal is allowed to fall behind the operation in a controlled manner. The supports make possible high levels of production and safety. Sensors detect how much coal remains in the seam while robotic controls enhance efficiency. Longwall systems allow a 60-to-100 percent coal recovery rate when surrounding geology allows their use. Once the coal is removed, usually 75 percent of the section, the roof is allowed to collapse in a safe manner.

Continuous Miner used underground

CONTINUOUS MINING utilizes a Continuous Miner Machine with a large rotating steel drum equipped with tungsten carbide teeth that scrape coal from the seam. Operating in a room and pillar (also known as bord and pillar) system-where the mine is divided into a series of 20-to-30 foot (5-10 m) rooms or work areas cut into the coalbed , it can mine as much as five tons of coal a minute, more than a non-mechanised mine of the 1920s would produce in an entire day. Continuous miners account for about 45 percent of underground coal production. Conveyors transport the removed coal from the seam. Remote-controlled continuous miners are used to work in a variety of difficult seams and conditions, and robotic versions controlled by computers are becoming increasingly common. Continuous mining is a misnomer, as room and pillar coal mining is very cyclical. In the US, one can generally cut 20 ft or 6 meters (or a bit more with MSHA permission) (12 meters or roughly 40 ft in South Africa before the Continuous Miner goes out and the roof is supported by the Roof Bolter), after which, the face has to be serviced, before it can be advanced again. During servicing, the continuous miner moves to another face. Some continuous miners can bolt and dust the face (two major components of servicing) while cutting coal, while a trained crew may be able to advance ventilation, to truly earn the continuous label. However, very few mines are able to

achieve it. Most continuous mining machines in use in the US lack the ability to bolt and dust. This may partly be because incorporation of bolting makes the machines wider, and therefore, less maneuverable.

ROOM AND PILLAR MINING consists of coal deposits that are mined by cutting a network of rooms into the coal seam. Pillars of coal are left behind in order to keep up the roof. The pillars can make up to forty percent of the total coal in the seam, however where there was space to leave head and floor coal there is evidence from recent open cast excavations that 18th century operators used a variety of room and pillar techniques to remove 92 percent of the in situ coal. However, this can be extracted at a later stage .

BLAST MINING OR CONVENTIONAL MINING, is an older practice that uses explosives such as dynamite to break up the coal seam, after which the coal is gathered and loaded on to shuttle cars or conveyors for removal to a central loading area. This process consists of a series of operations that begins with cutting the coalbed so it will break easily when blasted with explosives. This type of mining accounts for less than 5 percent of total underground production in the US today.

SHORTWALL MINING, a method currently accounting for less than 1 percent of deep coal production, involves the use of a continuous mining machine with movable roof supports, similar to longwall. The continuous miner shears coal panels 150 to 200 feet (40 to 60 m) wide and more than a half-mile (1 km) long, having regard to factors such as geological strata.

RETREAT MINING is a method in which the pillars or coal ribs used to hold up the mine roof are extracted; allowing the mine roof to collapse as the mining works back towards the entrance. This is one of the most dangerous forms of mining, owing to imperfect predictability of when the ceiling will collapse and possibly crush or trap workers in the mine.
