CHAPTER 11

INUNDATION IN MINES

Abandoned mines and quarries get filled with water and pose a problem for the working of mines below and near such water fogged areas. The worst disaster caused by inundation of mines was at Chasnala colliery in Bihar in 1975 when 372 persons were drowned underground during drivage of underground galleries which were approaching waterlogged old workings of an abandoned mine.

Most of the accidents resulting in inundation have arisen due to -

1. The inaccuracy of old plans.
2. The lack of old plans.
3. Errors of judgement of neglect of precautions.
4. Unsuspected presence of old shafts, boreholes or drifts connecting old galleries full of water. Unexpected variation in the throw of faults is sometimes a contributory factor.
5. Encroaching, intentionally or unintentionally, into the workings of adjacent mines by crossing the common boundary when the state of workings of adjacent mines is not known.
6. Sudden collapse of water bearing strata (e.g. Kamptee series in Wardha Valley Coal Field) due to faulty method of working or insufficient roof suports.
7. Sudden bursting of a dam to hold water.

A phenomenon of potential danger by inundation sometimes arises in mines of Korba coalfield. At Korba and Surakachar mines it was observed that in development galleries potholes of the size of a well leading from the surface to the coal seam (depth 30 m to 100 m) appear all of a sudden without any warning or indication, Such pothole-subsidences have *taken* place in those mines near the fault planes but some cases have occurred even in galleries far away from the fault planes.

Plans should not be relied upon fully when approaching a common boundary or old workings. The safest procedure is never to take the position of old workings for granted until they have actually been proved by proper survey. Such survey however is impossible if the old workings are inaccessible. Plans of workings prepared at small mines of unscrupulous owners prior to 1956, the year of introduction of current Coal Mines Regulations, should be treated with caution as full time surveyors were not required at the mines under the Regulations.

The inaccuracies of old plans include—-

(1) Decrepit condition of old plans.
(2) Shrinkage and deterioration of the material on which plans have been drawn.
(3) Omission to show magnetic meridian or true north and lo apply variation in magnetic meridian in plotting workings in periodical surveys.
(4) Omission to show full extent of the workings.
(5) Omission to correlate the workings with the surface features correctly.
(6) Absence of spot levels at the junctions of galleries and/or of surface contours. It was not essential to show spot levels under the old regulations-

In a thick seam, if supervision by the supervisory staff is inadequate the galleries do not follow their proper gradients very often and they rise gradually due to the floor coal left by the coal cutting machine. Wherever one cuts, there is coal and the availability of coal does not attract attention of the management to the serious flaw in drivage of the galleries. If the thick seam is worked partly by quarry near the outcrop and partly by underground workings through an incline or a shaft, it is quite possible for the galleries in the underground workings on the rise side to be dangerously close to water logged quarry though the plans may indicate sufficiently thick barrier against the water.

The Coal Mines Regulations arid the Metalliferous Mines Regulations have provided sufficient safeguards when approaching water logged workings, either in the same mine or adjacent mine, above or below the existing working. *Regulation* 127 of the Coal Mine Regulations states as follows.

1) "Proper provision shall be made in every mine to prevent irruption of water or other liquid matter from the workings of the same mine or of an adjoining mine.
2) Where work is being done in
   a. any seam or section below another seam or section, or
   b. any place in a seam or section which is at a lower level than any other place in a lower seam or section, or
   c. any place in a seam approaching a fault passing through an upper seam or sections which contain or may contain an accumulation of water or other liquid matter adequate precautions shall be taken against an irruption of water or other liquid matter into the workings.
3) No working which has approached within a distance of 60 metres of any disused or abandoned working (not being working which has been examined and found to be free from accumulation of water or other liquid matter) whether in the same mine or in an -adjoining mine, shall be extended further except with the prior permission in writing of the D.G.M.S. and subject to such conditions as he may specify therein.

   Provided that if heavy seepage of waiter which is not normal to the seam is noticed in any working approaching but not within 60 metres of any such disused or abandoned working such working shall be immediately stopped and the D.G.M.S. and the J.D.M.S. shall forthwith be informed about the occurrence. The working shall not be extended further except with the prior permission in writing of the D.G.M.S. and subject to such conditions as- he may specify therein.

Explanation—For the purpose of this sub-regulation the distance between the said workings shall mean the shortest distance between the working of the same seam or between any two seam's or sections, as the case may be, measured in any direction, whether horizontal, vertical or inclined.

4) Every application for permission---- (*see regn. book).*
5) No such working shall exceed 2-4 m in width or height and there shall be maintained at least one bore hole near the centre of the working face and sufficient flank holes on each side and where necessary, bore hole above and below the working at intervals of not more than 5 m. All such bore holes shall be and shall be constantly maintained at sufficient distance in advance of the working and such distance shall in no case be less than 3 m. These precautions shall be carried out under the direct supervision of a competent person specially authorised for the purpose."

Apart from the provisions of the regulations other precautions which should be taken when approaching old water logged workings are as follows:—

1) Examine existing and old plans or records to determine the position of the old workings. Old plans are sometimes available in the office of the D.G.M.S. Information on the extent of the old workings and their condition can be had from old-experienced supervisory staff who might have worked during drivage of the old workings.
2) Instead of working a district, drive only one or two exploratory headings nearly at right angles to the general outline of old workings. In these headings maintain a system of advance bore holes at the centre and at the flanks as shown in Fig. 1. This precaution should be taken when the heading is within 60 m of the *probable* old workings. The bore holes should be at least 15 m long and templates should be used to drive them at proper inclination.
3) In a thick seam it is necessary to bore holes in upward and downward direction also.
4) Provide proper lighting at the working place and escape-route.
5) Drill the holes with a suitable machine like the Volsafe 500 boring apparatus which enables water, if tapped, to be shut off immediately by a valve. The machine is capable of drilling at any angle. (See photo plate)
6) Build emergency shut off door at about 15 m away from the site of boring machine for closing it immediately in an emergency.
7) Fill up the depressions on the escape route so that it is not filled with water, when tapped, and does not obstruct the workers when retreating in a hurry.
8) Provide a drain or pipe line of suitable size and gradient to deal with any possible flow of water when the make of water at the face increases or when the bore holes tap the old workings.
9) Appoint only experienced workers and supervisory staff at the face.
10) Increase ^he pumping capacity of the mine beforehand to deal with water when it is tapped.
11) Watch for any unusual seepage in the flow of water at the face or in the bore holes. It should however be noted that in some of the accidents due to inundation there was rarely any indication of increased flow of water at the working places.

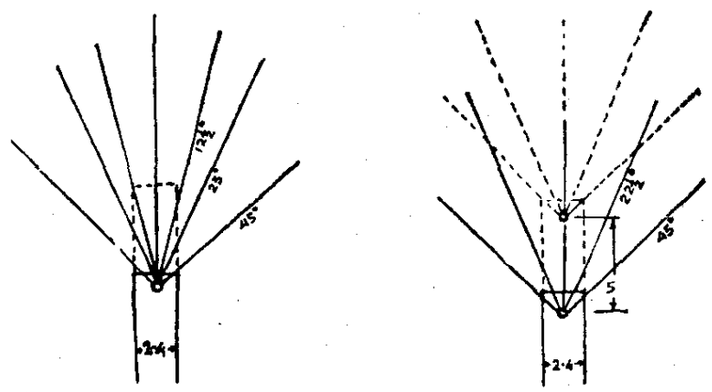
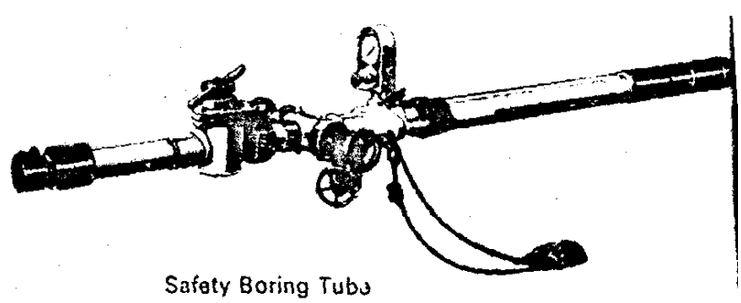


Fig. 11.1. Two patterns for advance and flank bore holes. Distances in metres.

An underground drilling machine which has replaced the once-familiar Burnside drilling equipment used when approaching water-logged underground workings is VOLSAFE-500 manufactured and marketed by Voltas Ltd. It can drill holes of 50 mm or 75mm in dia. upto a depth of 150 m at any angle upto 360° It is powered by an electrical flameproof motor of 15 H. P. A separate pump unit of 7.5 H. P. is used for water circulation but a pump to develope hydraulic pressure for hydraulic controls is integral part of the drilling machine and it has a capacity of 73 1. p. m. at 25 kg/cm^2- The drilling pipes arc only 1-5 m long due to underground limitations on lengths. The safety boring attachment of the machine can shut off water at a pressure upto 45 kg/cm^2 and avoids possibility of danger from water inundation.


Safety Boring Tubo

A pair of anchoring buckles has been provided as a safety measure to ensure that the attachment does hot come out of the borehole under pressure encountered due to water logging on the other side, AW drill rods can be inserted through the packing of the stuffing box—this being watertight during the time of boring. After the water is tapped, the full length of rods and drill bit can be withdrawn to outside the full way taper cock, the cock can be shut and the stuffing box unscrewed; then the drill bit can be withdrawn—this operation being perfectly safe.

***The* operating instructions in brief are:**

1) A 130 mm dia borehole is to be made to a distance of approximately 1-3 m in the core by any operating method preferably by using tungsten carbide core bit.
2) Loosen the cross head and insert the main tube assembly keeping the cross heads and tightening bolts outside. The rubber sleeves built inside the borehole end grip firmly against the periphery of the borehole by adjusting the tightening bolts.
3) Use the anchoring turnbuckle to hold the attachment *in* position.
4) Keep all valves in open position.
5) Remove the stuffing box from the attachment.
6) Loosen V-packing and slip over the drill rods which are to be used along with boring machine.
7) Attach bit to the rod.
8) Insert drill rod with drill bit in the attachment and tighten the stuffing box.
9) Connect the pressure gauge on the threaded cross head.
10) Close the release valve and check leakage by pumping water in the system. Rectify leakage, if any.

Now the attachment is ready for drilling operation.

Steps against inundation of mine workings

1) Maintain a surface plan of the mine with contours and showing particularly low-lying areas, lakes, water courses, boreholes, wells, dams, quarried outcrop zone. The highest flood level of stream, river, lake, etc. should be clearly marked. A common omission is of boreholes made during the prospecting stage as they are likely to be forgotten after the prospecting is over.
2) Cut suitable drains round the periphery of the quarry to prevent inflow of rain water or surface water into the quarry. Such drain is also essential near the incline mouth.
3) Ensure that there is sufficient cover over the roof of underground workings. It should be more than the prescribed limit of 15 m where the surface rocks are not well consolidated, e. g. in a large number of areas in Raniganj coalfield where the cover is of alluvium. This point assumes significance where the mine is worked by inclines and for the workings on the rise side if the mine is not deep.
4) If the mine is worked near the outcrop by quarrying or by inclines and the workings have been abandoned resulting in their water logging, leave a sufficient thickness of solid mineral (more than 60 m) between the proposed underground workings if the mineral on the dip side has to be worked by underground mining methods. Such precaution has been taken at Sudamdih mine,
5) If the strata above the mineral bed are permeable and outcropping in a river or lake, caving method of depillaring should be avoided unless the mine has adequate pumping capacity.
6) Where depillaring with caving is the method of mining and the mine is not deep, the cracks after depillaring are likely to reach the surface and during rainy season the rain water enters the mine through such broken ground. Adequate pumping capacity to deal with such inflow of rain water is essential.
7) Leave sufficient barrier of solid mineral against adjoining mine on the rise side of the mine.
8) Where dams have to be built underground to hold water, they should be of adequate dimensions and well anchored in the floor and roof stone and in the sides, to prevent leakage.
9) During the rainy season, if it is not possible to press into service extra pumps due to limited power or non availability of pumps, the inflow of water into the mine is sometimes beyond the capacity of the pump which has to be shifted at frequent intervals to the rise side workings. It is a good practice to keep in readiness pump foundations with holding down bolts suitable for the bed plate of the pump set so that the same pump can be readily dismantled and shifted to the rise side foundation and recommissioned without much loss of time.
10) Do not make any workings vertically below and within 15 m of either bank of a river, canal, or boundary of a lake or tank without permission of the appropriate authorities.
11) Observe the precautions laid down in the mining regulations when approaching waterlogged workings.
12) During the rainy season if the mine workings are near a river or lake, keep round-the-clock vigil on the water level and arrangements should be made for ringing an alarm in the attendance clerk's office and other suitable points when the water level reaches a predetermined level indicating approaching danger. Such arrangements normally consist of a float which, when raised by the water of the river or lake, closes an electric circuit incorporating an alarm bell. In some mines an additional alarm bell is located in the mine manager's bungalow, e, g. at Sasti Colliery,

Chasnala and Mahabir colliery disasters

Of the few inundation accidents in Indian mines, two will be remembered for long by the mining community, but for two separate reasons.

One inundation accident took place at Chasnala colliery in Jharia coalfield in December 1976 killing all the 375 miners present underground. A high grade thick coal seam, steeply dipping, was worked in that mine near the outcrop in the 1940's by opencast methods. When the cost of overburden removal became uneconomic, an incline was driven from the quarry for underground mining. The incline mine was later closed down and abandoned in the late forties when the working proved unprofitable. The incline mine and

the quarry had got filled with water in course of years. Early in 1970's, Indian Iron & Steel Co. took over the mine, sunk a shaft on the dip side of the property and was working it by underground mining methods. When approaching the abandoned water-logged incline workings, advance boreholes were drilled as required by the coal mining regulations. On the basis of the plans of abandoned mine that were made available to him, the mine manager was confident that the on-going workings were sufficiently away from-the water-logged old workings. He had accordingly pursued his mining operations but on the fateful day of the accident, one gallery, after blasting at the face, joined the old water-logged workings. The heavy inrush of water submerged the shaft, the only escape route, and drowned all the 375 miners present underground. This is the worst accident of inundation in Indian mining history. As was revealed in subsequent inquiry after the mine was dewatered, the plans submitted by the previous mine owners in the late forties to the DGMS office, had not correctly shown the extent of workings at the time of abandonment and the "solid block of coal" had, in fact, a few worked out galleries, omitted in the mine plan.

Another inundation accident at Mahabir colliery of Eastern Coalfields Ltd, in November 1989, had trapped about 230 miners underground but all except 71 persons could come out of the mine through the mine shaft. Out of the 71 trapped miners, 65 were rescued with the help of a rocket-shaped metal capsule lowered in a specially drilled borehole immediately after the accident, highlighting the unparalleled rescue operations in mining history not only in India but in the world.

Mahabir colliery used to raise about 500 te per day of coal from development drivages in Narayankuri seam. Overlying Nega seam 25 m above had been worked decades ago and had been abandoned. It was filled with water. This water gushed into the workings of Narayankuri seam around 4 A.M on 13th Nov 1984 after blasting at one of the development faces, the roar of the gushing water alerted the workers and of the 230 miners present in the mine, all except 71 managed to escape to the surface by the mine shall. These 71 miners could not come to the surface as the shaft had got submerged and they were taken to the dry rise area by the two mining sardars who were amongst the 71 trapped miners. Fortunately telephonic communication from the surface to the area of shelter was available and maintained. Trapped miners could talk to their friends and relatives over the phone. They were supplied drinking water, food and medicines from the surface through a 200mm borehole dug immediately after the accident for the purpose. Pumps were installed at the shaft to hold back the water level from reaching the trapped miners. On the rise side a borehole 33 m deep was drilled and reamed to 600mm diam. It was encased by a 525mm internal dia. casing to prevent collapse of the soft soil and a specially made capsule of iron sheet, 443 mm internal dia., fabricated at workshops of ECL, was lowered, along with an officer, by crane to the trapped miners. The men were hoisted in the capsule one by one and by the morning of 16th Nov. 1989, 65 trapped miners were rescued to the surface. Six miners could not be traced despite all efforts. When the mine was dewatered, their dead bodies were traced.

Trapped miners used the cap lamps sparsely, one lamp being used by a group of 10. They took only small quantity of food to maintain body equilibrium.

This rescue operation with the help of a capsule was the second of its kind in the world: the first one had taken place in Germany.

The design of the capsule was given by Prof. A. Ramulu.

QUESTIONS

1. What arc the main causes of accidents in a mine? Which cause accounts for the highest casualties?
2. State the precautions to be taken when approaching old workings containing water.
3. State the factors which make the old plans unreliable.

Reader's Digest of June 1991 gives a vivid narration of the Mahabir colliery disaster and the rescue efforts.