Shaft sinking

Sinking vertical shafts

Preparatory work

Before a shaft can even begin to take shape, some preparatory work must be done. Topographical work which must precede construction includes:-

i) A survey to provide contour lines at 250 - 500 mm vertical interval for 150 - 200 m radius around the shaft & at 1 m vertical interval for 250 - 500 m from shaft.

ii) Fixing the centre of the shaft by permanent survey points at locations where they will not be disturbed during construction & from which shaft centre points can always be relocated.

iii) Marking out the main axis of the shaft.

iv) Establishing by Bench marks, the elevation decided for the collar of the shaft, which usually becomes the local datum. All future structures will be set relative to the collar level & ~~rela~~ levelling surveys will be tied in with it.

Geological investigations must define exactly the type of rocks which the shaft will pass through, but above all the levels which are water bearing, where water can flow into the shaft during sinking & the chemical nature of the u/g water. For this purpose, at a little distance from shaft, not more than 50-60 m a special ~~ore body~~ bore hole is sunk 50 - 75 mm in diameter. This bore hole should not be drilled at centre of shaft because if it is, water under pressure may rise up through it & flood the shaft during sinking.

The surface soil is investigated by shallow bore holes & by test bits so as to determine the bearing capacity of the soil, the level of the ground water & its propert

Well organised transport, Power supply & Industrial Water s
should be available from start of construction. Boiler
sent to compressor for cooling. it is also needed
Concrete, mortor, fire hydrants, drinking, washing, laundry

The main consumers of electricity are the wi
engines, pumps, compressors & . The electrical
during sinkig depends on the number of shafts b
sunk simultaneously, their cross-section & their dept
for dep sinking two shafts by modern methods, t
start power would be between 1300 to ~~to~~ 5000 kW,
because all the machines do not work at the sa
max demand would between 250 to 3000 kW. If no pow
or supply exists nearby, a mobile power station may b
during the period of shaft sinking, with road vehicle
rail cars carrying the generator.

Method Of Shaft Sinking

The method of sinking a shaft is decide
mainly with a view to the geology & ground water. Acco
strength of the ground & its water bearing cor
method of shaft sinking is either

Conventional · Special

Conventional methods are used for sinking
strong relatively dry ~~or~~ area. When the water in the
easily handled by sinking buckets or by pumps &
stand well behind even temporary support.

Special methods are used for sinking through
friable or flowing ground. of ground which is hi
(water bearings) when the face makes 20-30 n
or more.

Conventional Shaft sinking Includes 3 di

the walls & equipping the shaft

2.) Subsidiary work including hoisting, pumping, ventilation & lighting.

3.) Services such as power supply, water supply, transport, stores, repairs, housing & community life.

According to the sequence of the sinking & the permanent lining of the wall, the work can be done in 2 ways:

i) Alternate sinking & lining

ii) Simultaneous sinking & lining.

In the first method, the shaft is sunk downwards in lengths of 15 - 80m, the lining is being built upwards from the bottom so that it cannot be started until work at the bottom has seized. Sinking alternate & lining, the lengths of sinking are decided upon in relation to the strength of ground, in flow of water & general organisation of work.

In 2nd method, sinking continues at the bottom, while lining is underway in a slightly higher section of the shaft to ensure safe working conditions in the shaft, the two sections are separated by special protective stage or walling stage.

Shape & Size of Vertical shafts

The main modern cross-sections of vertical shafts are ~~vo~~ rectangular & circular. After the shape of the cross-section has been chosen, its dimensions are settled. The dia. of a circular shaft & length of sides for a rectangular shaft.

The dimensions of a shaft are determined graphically on the basis of -:

i) Outside dimension of hoisting cages or skip

ii) Clearance gap b/w cage or skip & lining, which is not less than 140 mm with steep ~~rise~~ guides & not less than 200 mm for [redacted] guides.

iii) The clearance of 200 mm b/w two moving cages or skip when there is no buntor b/w them.

iv) The clearance b/w the cages or skips & buntor for those which do not carry guides & 70 mm for those that carry guides

v) The width of the bunton

vi) The cross-section (width & length) of the ladder compar

vii) The cross-section of the compartment for cable & pipes

viii) The cross-section of shaft-deepening compartment, if th is one.

The main elements determining the cross-section the area & therefore the capacity of hoisting skip or cag the weight of mineral hoisted at any time depends on the hourly output needed from the shaft & thus on a number of winds possible / hour.

The hourly output, q, in tonnes is determin from the formula

$$q = \frac{kA}{N \cdot n}$$

where k = Irregularity factor of the hoisting

A = annual output of the mine

N = no. of working days/yr

n = no. of hoisting hrs/day

The annual output, A, of the mine is usually stated in the project for the mine & is therefore known quantity in determi cross-section of shaft.

The number of working days/yr depending on the or sation can be taken as 300 or 350. The first figure is applicable for usual ~~un~~interrupted working week, The second figu to the continuous working week.

The number of hoisting hours/day is 14 to 21 hour if the shaft is used only for hoisting minerals (14 fo 2 shift working & 21- 3 shift working). If the hoisting capacity is used also for subsidiary purposes, an accurate estimate of time spent on subsidiary hoisting is needed.

The possible number of hoist/hr, n, is obtain from the equation $n = \frac{3600}{T}$, where 3600 = no. of sec's/ho T = total hoisting time in seconds determined from eqn

$T = t_1 + t_2$

where t_1 = duration of wind in s

t_2 = interval b/w winds

The duration of the winds can be obtained from empirical formula.

$t_1 = 2.5\sqrt{h}$, s

h = depth of mine, which is roughly equal to depth of shaft

The duration of interval depends on type of hoisting installation & shaft top n bottom stations.

With typical cage hoisting & a two sided shaft station t_2 = 12, 30 or 50 s with single deck, double deck & 3 deck cages respectively. with two mine cars at each deck

t_2 = 50 s for each deck taking operation.

with a single sided shaft t_2 = 30 s for each deck.

with self dumping cages t_2 = 10 s, when skips are upto 6 tonnes capacity, t_2 = 8 s for capacity above 6 tonnes t_2 = 10 s

For man winding by cage, t_2 usually has the following value

5 men	15 s
10 men	20 s
15 men	25 s
20 men	30 s

+5 s for every change of deck (levels)

Knowing the necessary hourly output of hoisting & the possible number of winds / hr, we can determine the mineral ore hoisted.

$$w = \frac{q}{n} = \frac{kA}{Nn} : \frac{3600}{T} = \frac{KAT}{3600Nn}, \text{ tonnes}$$

Empirical formula

$$q\,\frac{2.05\sqrt{H}+17}{3600} \le Q \le q\,\frac{4\sqrt{H}+9}{3600}, \text{ tonnes}$$

The above empirical formula is used for determining skip capacity (load hoisted) where

q = hourly hoisting output (in tonnes)

H = hoisting depth in m

Q = skip capacity in tonnes.

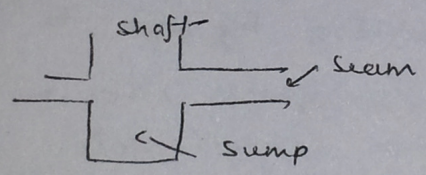
Knowing the quantity of mineral raised / wind, it is possible to choose the type & capacity of skip & therefore its size

The buntons can be wooden or steel

If wooden, they are made of oaks, baulks from 150 X 200 200 X 300 mm in cross-section

Steel buntons are ~~20 to~~ 22 or 36 cm deep I - sections.

The guides can also be wooden or steel. Timber for guides are 6m long & either 140 X 160 or 160 X 180 or 18 mm in cross - section. Steel guides are 12.5 m long rai sections, 12.5 cm deep & weighing 38.4 kg/m. The ladder compartment is usually 1.2 m wide. In some other mines, rop guides are used & buntons are therefore not needed f supporting them. The ropes are hung from the F - f & tension equal to weight in sump.



The shaft cross - section within the lining is the clear cross - section as for any mine working. determine the excavated dimensions, the lining thickness be known. The As explained above, the dia. of circul shafts in coal mines are standardized from 4 - 8 m at intervals of 0.8 m. 3 rectangular cross - section of shafts 2950 X 2000 ; 4000 X 5000 & 4000 X 5300 mm