Chapter VII

GRANITE INDUSTRY IN CHITTOOR DISTRICT AND ITS QUARRYING METHODS AND PROBLEMS
CHAPTER VII

GENERAL

Black Granite being the most quantative material among naturally available building stones requires thorough understanding of its commercial characteristics and intrinsic aesthetic qualities. Though the black granite deposit occurs in abundance in different kinds in Nature, yet they cannot be indiscriminately quarried and misused. Conservation of the deposits for futures posterity, formation of ways and means to traduce the enormous generation of solid waste in quarrying and likely geological hazards on account of large scale unscientific quarrying are the vital aspects that attract the attention of geoscientists all over the world, for evolving immediate corrective measures. One of the corrective measures that offers immediate partial solution is adopting a scientific method of quarrying. The quarrying of Black Granite blocks comprise three major phases, such as pre-quarrying phase, operational phase and post quarrying phases. Significance of the granite quarrying techniques and its requirements are highlighted here in.

PRE QUARRYING PHASE

Implementing pre-quarrying phase is as essential as that of adopting a scientific, modern method of quarrying. The pre-quarrying phase includes the following stages.

- Selection of a suitable site/deposit for quarrying after making adequate provision for safety zones as per statutory laws in force.
- A detailed study on the geological aspects of the selected black granite deposits.
- Techno economic and commercial viability of the black granite deposits.
- Developing suitable, adequate infrastructure such as good approach road, availability of potable water, man power etc.
- Logistic requirement of men and machineries.
- A proposed quarrying plan, to be revised and updated as and when quarrying progresses.
OPERATIONAL PHASE

On completion of the above stages (pre quarrying phase), method of quarrying the granite deposits will be proceeded on the following ways.

QUARRYING IN EARLIER TIMES

When dimension stone quarrying was in its infancy, the task was essentially manual, making use of hand tools such as crow bars, chisels, spades, sledge hammers etc. Drilling, channeling, grooving, etc. were all made making use of these requirements. Blasting was restarted to dislodge large size blocks. Exfoliation was induced in certain black granite deposits by burning wood, charcoal, etc. along particular direction and blocks were heaved, split with crow bars as levers and rolled on wood lodge to dressing yard for sizing and trimming.

A slight improved version in the above primitive techniques is the usage of feather and wedge to create the desired splits. Close spaced chisels made drill hole along the desired plane with a spacing of about 15cm depth around 10cm were plugged with feather wedges and hammered uniformly to create artificial split(Ramalingam, 1995).

The above techniques were replaced with the introduction of compressor and cranes of different capacities which were made use of to drill holes and to handle large size blocks respectively. They along with hand tools play an essential role, even today, in substantially mechanized quarry (Rajaram, 1998).

Quarrying in recent times (Taboda, 1998; Richard Prikryl, 2004);

- Stripping up of over burden and exposing the deposit for quarrying
- Primary cutting of the deposit for removal of large size blocks
- Secondary cutting of large blocks into smaller blocks
- Splitting and squaring of blocks into required sizes for direct export/processing in a factory.
QUARRYING METHODS IN CHITTOOR DISTRICT

Granite quarry normally consists of Yard, work face, Edge, Foot, Dump and Plant. The quarrying operations begin in the Yard and this gets larger as the excavation proceeds. The area represents the heart of the Quarry. It is here that the 1st stage work is carried out, squaring off, stockpiling and loading the blocks. The support structures needed for the operation of a quarry, are usually situated on the frontage of this area. These include, the change room / rest shelters, first aid drinking water arrangement for employees.

The Mining / Stopeface / Workface is the area where excavation actually taken place.

The waste dumps are not productive areas and used to dispose of the off grades and are used to dispose of the cut off grades and waste material. The top of the Quarry is called the Edge. The fool is the base of stopeface. Plant includes necessary equipment to carry out excavation.

The Traditional Equipment and Techniques used in stone quarrying are briefed as under:

1. Hellicoidalwire cutting equipments.
2. Diamond wire cutter.
3. Chain cutter.
4. Pneumatic Block cutter.

Granite quarries are on increase and are usually of open pit type and the excavation method is governed by the size of deposits. As described earlier, the granite deposits generally exhibits long ridges of dolerites, with 30 to 40m width and stopping / mining faces and different faces at different depths, depending upon the sizes of faces, the excavation can proceed, in a single step mode or more than one step can be worked. These benches can be as high as 6m making it a highly efficient excavation phase (Plate XII, Fig1).

Formally in India even today, majority of granite quarries are operated by manual methods on rat hole and rat race mode without any scientific and proper planning. Shallow indentations were made in a straight line, exploiting the natural breaks and joint planes wherever possible, using steel bars. Wedges
were then placed in these holes and hit systematically and simultaneously by number of people until separation takes place. The cuts produce very regular surfaces because of the nature of stone.

The above manual operations have been reduced greatly in the recent year with the advent of compressors and jack hammers and lately with the use of pneumatic block cutters. With this equipment a series of parallel holes are made in the stopeface (Plate XII., Fig2). The holes are generally 25 and 35 mm in diameter and drilled at 20 cm interval to appropriate depth which inscribes the block to be cut. The mechanical stress or shock wave in the holes is applied to overcome the cohesive strength. Mechanical stress can be applied by percussion of wedges placed in the holes by number of people till the separation of blocks takes place.

**Blasting methodology**

Before commencing the quarry operation, the essential aspect to be understood is the blasting methodology. Granite being a hard material, require blasting at every stage, be it for removing the overburden, cutting the bench or extracting the large size blocks from the sheet rock. Rift, grain and hard way, the three orthogonal directions in a granite body facilitate easy blasting without many side effects, provided they are assessed properly and effectively utilized. Blasting methodology in granite quarrying can be categorized as follows (table) (Singh and Singh, 1995).

1. Bench blasting for various fragment sizes,
2. Controlled and contour blasting and
3. Special form of blasting for dimension stones

   of the above, the first one is for overburden removal and the remaining two for dimension stone extraction. Blasting methodology depends on several factors such as

1. The physio – mechanical properties of the rock
2. The geological structure of the rock
3. Specific drill (blast hole diameters)
4. Specific charge
5. Drilling pattern
6. Hole inclination and
7. Hole deviation

Influence of the above factors on rock fragmentation and splitting varies widely from rock type to rock type requiring several round of test firing and standardizing the methodology for the particular rock type/deposit. Different rocks have different propagation velocities and a rock having high propagation velocity requires an explosive with a high velocity of detonation (VOD). The opposite is the case in a rock having low propagation velocity. It has been observed that the explosive EMULITE and DYNAMEX with a velocity of detonation of 5000m/s to 6000m/s are suitable for blasting granite deposits. Multiple rows blasting with optimum length of delay between successive rows given good fragmentation, controlling at the same time the incidences of fly rocks, air blast and boulder uplifting. Too short a delay creates an upward heave in the rock of back rows. Similarly too long a delay causes a fly rock; air blast etc. single row blast is delayed in dimension stone quarrying. Similarly closely spaced, small diameter blast holes give much better fragmentation than the widely spaced large diameter blast holes. Increase in blast holes diameter trend to increase the dimension of overburden nearly to bench height and also makes the explosive work less effectively.

In case of dimension stone quarrying, blasting procedure varies somewhat different from the normal bench blasting for fragments.

- The specific charge has to be low from normal range of 0.32 to 0.52 kg/m³, to a decreased quantum of 0.20kg/m³ which is just sufficient to loosen the rock without any fragmentation.
- The spacing / burden ratio (S/B) should be less than 1. The ideal ratio is between 0.5 and 1.0 which yields blockier fragmentation.
- Blasting of one row at a time, preferably instantaneously is required for optimum block size recovery.

"to obtain the size of the block of one dimension 1.5X1.5X2.0 m the contour of the block is drilled with a spacing of 0.2m and the holes are
changed with 2 strings of 10 gm/m PRIMA CORD. The sides and the bottom are fired simultaneously and the combined force from the charges cuts the blocks loose from the rock, just moving it a few centimeters. Normally no stemming is used. Sometimes water is used as stemming in the vertical holes which seems to decrease the quantum of micro cracks around the holes" (Singh and Singh, 1995).

**Stripping up of overburden**

Sometime back, removal of overburden was essentially a manual affair. In South India, being heavily populated, there was no dearth for man power and hence substantial labour force was deployed for overburden excavation. However the task was tedious with low rate of saleable production. With the advent of poclains /excavators the task became easier and production enhanced manifold. Nature of overburden varies widely – purely soil to admixture of soil and boulders and to weathered top surface of granite. Poclain is a versatile invention meeting out the various demands of quarry operators as well as effectively tackling the varying nature of overburden. The poclain, whose bucket capacity varies between 0.9 and 1.2 cbm, not only excavates but also pulls, lifts, drags, consolidates and thus performs multifarious activities.

**Primary cutting** (Ajay Kumar & Srinivas, 1995)

Once the overburden is removed, mother rock/sheet rock gets exposed over which primary cuts are made for removing very large size blocks. What was considetered an impossible task earlier, quarrying techniques have made rapid strides in recent times and handling of heavy tonnages of material has become a child’s play. Various methods of primary cutting are as follows.

**Flame / Burner Cutting**

Jet burner is a thermal unit particularly suitable for making cuts in variable expansion rocks containing a high percentage of quartz. Making use of standard diesel oil (or kerosene) together with compressed air, the flame is let out through a narrow nozzle of diameter 54mm to 77mm with air power/diesel exit pressure at 6/7 atmosphere. The resultant is high cutting speed which makes cuts having widths 70-110mm and depth upto 4.5 mts. Flame cutting is
invariably adopted in almost all black granite quarries by quarry owners without even making an attempt to gain first hand information on thermal co-efficiencies of rock types, with the result certain deposits withstand flame cutting method. Wherein others it propagates fractures and micro fractures, thereby destroying the utility value of the deposits. The main drawback herein is the high noise level generated by the unit, about 130 db (A) which is distinctly considered as noise pollution. (Srinivasan, 1995; Kanishkan, 1995).

**Diamond wire saw cutting**

This technique has been in vogue since 1984, undergoing modifications and upgradation. In homogenous rock, apart from vertical cutting, horizontal cuts are also made. The diamond wire saw, fitted with 100hp diesel motor is linked to a wire-drive pulley through a hydraulic torque converter. The converter engages the diamond wire and with 3000 rpm the driving speed is selected between 15 and 40 m/sec. In addition to 360° rotation, the drive pulley moves axially a maximum of 250mm. This enables the machine to effect dangled cuts. The equipment is fully automatic with provisional for auto stopping during emergencies such as wire breakage, motor overheating insufficient oil pressure etc. The diamond wire consists of a steel carrier wire on which are placed alternatively diamond impregnated beads and injected plastic spacers. The spacers protect the carrier wire against the abrasive action the granite whilst at the same time providing a solid fixing for the beads. The diamond wire saw cutting has as many advantages to its credit such as (Rajaram 1998):

- High sawing speed which varies between 2 sq. mt and 5 sq. mt per hour
- Reduced laws of materials
- Saves squaring operation
- Simple to use
- Flexible in orientating the angle of cuts
- Reduced noise level
- Reduced consumption of explosives.
Cutting by line Drilling Machines

Variously designated as slim bar, liner Twin Liner, Maxi flexi etc, the equipment does the basic function of loosening large blocks from mother rock. A series of parallel holes are drilled along a straight line into the rock both vertically and horizontally. Entire drilling operation is mechanized to achieve required drilling capacity, low utilization cost and maintain a safe and free from health hazard quarrying. The units is precisely automated to drill to required depths, adhere strictly to the angle of inclination given and maintain correct spacing between two drill holes. The drilled hole diameter ranges between 27mm and 40mm, depending upon the machine used. 150-500 drill meters per shift are achieved. The unit is either mounted on structural frames or shifted on railings from one quarry face to another or in excavator beams. To achieve flawless quarrying operation and optimum output, certain principle governs drilling procedure and pattern (Tomrock Quarry line Method, Finland).

- Vertical drill holes should not touch the horizontal holes but stop at a height of about 15 cms;
- Alignment of drill holes is perfect so as to avoid shattering effect in the rock while blasting;
- The angle of horizontal drill holes is around $1^\circ$ - $3^\circ$ downwards;
- Hence the angle between vertical and horizontal holes is greater than $90^\circ$.
- Hole spacing in vertical lines varies between 15cm and 40cm and in horizontal lines, 20cm-50cm; optimum spacing of drill holes differ from rock type to rock type and it has to be arrived at by trial and error method in each quarry;
- Economical hole diameter is generally 32mm for both vertical and horizontal holes.

After having drilled the holes, detaching of blocks is by smooth blasting wherein the denotation effect is directed from one hole to the next. In modern day quarries, primary drilling constitutes about 20% - 45% of total operations.
Water Jet cutting (Aravindan et al., 1995, Foldinaet al., 2004)

High pressure water jet is being tried at present in dimension stone quarrying. Water pressure close to 400 Mpa and a flow of 25 liters per minute through a nozzle of less than 1mm dia effectively cut the rock to desired sizes. In spite of its certain advantages such as automatic cut with minimum of labour force, easy transportability of the unit, non-corrosive/non-abrasive action in areas immediately adjacent to the cut, compensation of higher cutting cost by high cutting speed etc. The main disadvantage of this modern machinery is limited range of cutting depth.

Secondary Cutting

The line drilling machines stated above perform secondary cutting operations also. In slight modification of earlier method, vertical holes of diameter 22mm – 29mm meet the already horizontally detached floor of the block and remove the secondary blocks. Instead of resorting to blasting for removal of secondary blocks, recent innovations such as hydrobags or hydrosplits facilitate easy pushing of blocks by generating tremendous force in the cuts/holes made earlier. Hydrobags are inserted at regular intervals on the cut made in the mother rock, earlier by the diamond wire saw. A thrust development of 300 tones is generated which pushes the blocks on a sand bed. The hydro bags are disposable after use. This revolutionary hydraulic cushion is increasingly used in almost all quarries in Italy, Hydrosplits operate in drill holes under similar principle with thrust development of around 230 tones.

Splitting and Squaring

What is called in India 'dressing' of blocks, the final phase in the quarrying operation is splitting of the secondary blocks and quarrying of tertiary blocks into regular sides. Equipments variously designed as Mini flexi, Trimmer Block dresser etc; dress the blocks into perfect rectangular sizes, thereby avoiding uneven bulges or cavities, wastage of material and over tonnage of blocks.
Supporting Machineries

Derrick cranes, winches/drag lines are the additional machines that are required along with the main quarrying machines. Apart from derrick cranes, quarry operators in India, are quite familiar with the other types of machines which are commonly used in almost all quarries.

Quarrying Vs Productivity

Method of quarrying has a direct relationship with productivity. In traditional method, quarrying is by and large controlled by geological structures such as joints, fractures, shears, veins etc. and the type of formation. In modern method, they have been treated as a part and parcel of deposits and totality in quarrying and elimination of defects at the time of processing has enhanced the productivity factor to a substantial level. Increased automation has decreased human errors and blocks obtained are perfectly planner on all sides thereby saving valuable time and enormous volume of material (which would have otherwise ended up as solid wastes). Perfectly squared blocks facilitate easy handling, low costs in transport and ocean freight charges and reduction in down-time operations at the time of processing. Above all, blocks so produced have ready market access with very high fetching rates.

PROBLEMS ENCOUTERED IN DIMENSION BLACK STONE QUARRY STUDY AREA:

Selection of working face without taking into consideration of the geological aspects may lead to high expensive with more rejection and low yield.

Detailed study on petrology, petro-chemistry, and mineralogical composition are all the more essential. As the aesthetic appearance will play a vital role on the basis of which portions should be selected for cutting and polishing. E.g.; Tiger black, Star galaxy

Certain deposits will not with stands for heat invariably using the jet burner in the granite quarry for making the primary channel/block from the parent rock may causes the deposits become unsuitable for commercial exploitation.
There are many problems in quarrying for dimensional stones in Chittoor district they are:

1. Unscientific selection of faces without taking into consideration of geological factors. In granite quarrying, the block marking is itself is an art and for this purpose close mineralogical and petrological examination and studies are essential and also their aesthetic exposition when they are cut and polished in different directions and patterns. Similarly, using jet burner for marketing channels in the massive granite required mineralogical study.

2. Hydrological conditions in the lease area and many other local factors.

3. Damage due to blasting in drillholes improper and unnecessary blasting in overcharge etc., lack of technical knowledge and wrong selection of explosives.

4. Damage due to improper handling

5. Lack of trained and skilled personnel

6. Lack of availability of right machinery by the right job, and non-availability of spoves in time.

7. Lack of knowledge about commercial aspects.

8. Lack of proper understanding in the hierarchy of the management.

Among the problems stated above the most important problem in the granite quarry is geological aspect of the deposit. The bask granites occurring as dolerite dykes running in a linear fashion with small width runs over long distances. Most of the dykes are highly jointed and traversed by number of felsic and mafic veins. In Chittoor district most of the workable deposits without much defects are situated on top of the hillocks which may range between 30 mts to 300 mts. Laying a road up to top of the hillock involved high cost due to which the cost on all overheads are also high. As such the returns from such quarries are placed at low, with increase production level though the renumeration from such quarries is only hand to mouth.

Due to lack of technical knowledge many of the people suffered setback in the granite industry. The entrepreneurs who have good financial background
could withstand with the early losses and they are regained the losses when they developed the quarry ayatomatically. Mear occurrence of granite deposits may not facilities for developing the quarry since it requires through knowledge with the mineralogical composition nature of defects and obtaining exportable sizes of blocks. Even after developing the blocks of exportable sizes after investing finance if they contain patches of other minerals are differential grain texture such blocks are not fetch the price the cost involved in it.

In view of this the variable which require further study in this adoption are

- Depth of drilling both in horizontal and inclined holes;
- Spacing of horizontal drill holes
- Quantum and Quality of blasting
- Thermal co-efficiency of the rock type and
- Quantum of material wasted.

Further refining of this procedure will undoubtedly help in adopting similar techniques elsewhere in deposits of similar massivity and geological milieu.
PLATE – XII

Fig. 2: A series of parallel boles a made in the stope face of the black granite.