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GRANITE

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GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

Indira Bhavan, Civil Lines,
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471
PBX : (0712) 2562649, 2560544, 2560648
E-MAIL : cme@ibm.gov.in
Website: www.ibm.gov.in

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24 Granite

Granite technically refers to a light-coloured granulose plutonic rock composed of felspars, plagioclase, quartz (35% approx.) and minor amounts (45% approx.) of mafic minerals, such as, biotite, hornblende, pyroxene, iron oxides, etc. But, in commercial parlance, the term granite has become synonymous with all those crystalline rocks which have pleasing colours, strength to bear the processes of quarrying and cutting & polishing and which are used commonly for decorative purposes. Being more resistant to wear and tear as well as weathering, granite is most sought-after stone to be used for building as well as decorative stone. The fascination for granite is due to its amenability for taking mirror-like polish, high compressive strength, longevity and aesthetics. India possesses enormous deposits of all types of dimension stones. It is one of the prominent producers of dimension stones in the world. The Dimension Stone Industry employs a workforce of over one million at its various sectors. This Industry plays a vital role in the economy of the states like Tamil Nadu, Andhra Pradesh, Karnataka and Rajasthan. Rural economy of many developing States like Madhya Pradesh, Uttar Pradesh, Odisha and North-Eastern States is dependent on this Industry. Granite industry is valued at $40 billion and has a potential to generate semi-skilled employment further, in rural areas.

Within the country, granite used for decorative purposes is considered costly when compared with other materials, hence, its utilisation and trade in the domestic front has been relatively low when compared to its export potential.

RESERVES/RESOURCES

India is endowed with abundant resources of wide variety of granite comprising over 200 shades. As per NMI data base, based on UNFC system, as on 1.4.2015, reserves/ resources of granite dimension stone of all types have been estimated at 46,320 million cubic metres. Of these resources, 264 million cubic metres (less than 1%) fall under reserves category, while the remaining 46,056 million cubic metres (about 99%) fall under resources category.

Of the total granite reserves, about 36 million cubic metres of all grades fall under proved category while 228 million cubic metres falls under probable category.

State-wise breakup of total resources reveals that Karnataka & Rajasthan share about 20% each of the resources which are followed by Jharkhand (19%), Gujarat (18%), Andhra Pradesh (5%) and Madhya Pradesh (4%). These states together account for 86% of the total resources. Gradewise classification reveals that about 7% of the total resources fall under black granite while 92% under coloured granite. About 1% resources are of unclassified grade.

The details of reserves/resources as on 1.4.2015 are furnished in Table-1.

PRIME VARIETIES OF INDIAN GRANITE

In the world market, there are nearly 300 varieties of granite of which India supplies about 200 varieties. Out of these, prime varieties represent a wide spectrum of colour, texture and structure. These prime varieties have substantial resource base. Commercial names of granite are derived from area, colour, patterns, etc.

Karnataka specialises in the production of Ruby red, Chilly red, Cera grey, Kanakpura multicolour, Himalayan blue and Sira grey varieties of granite. Andhra Pradesh is famous for Black Galaxy, Srikakulam blue and Black varieties of granite while Tamil Nadu is abundant in Jet-black & Tipu-white, Kashmir-white and Paradiso sea green varieties of granite. Odisha specialises in Pink granite, Silver grey, Sea weed Green, Chilka blue, Grey wave varieties of granite. Availability of varieties of granite in various States is furnished in Table- 2.

EXPLORATION & DEVELOPMENT

The increase in demand both in domestic and international markets for new varieties of granite has prompted DMG, Government of Rajasthan to get significantly engaged in exploration activities. The details of work carried out by the GSI in Madhya Pradesh and State Directorates of Rajasthan in 2015-16 are summarised in Table- 3.

Table – 1 : Reserves/Resources of Granite (Dimension stone) as on 1.4.2015
(By Grades/States)

(In thousand' cubic metres)

Grade/State	Reserves				Remaining resources								Total resources (A+B)
	Proved STD111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
		STD121	STD122			STD221	STD222						
All India : Total	**35741**	**201377**	**26574**	**263692**	**38462**	**51990**	**8234**	**837325**	**2063964**	**42543908**	**512216**	**46056098**	**46319790**
By Grades													
Black Granite	6936	6060	3909	16906	-	45690	1	50934	466039	2572581	23538	3158783	3175688
Coloured Granite	28805	195316	22665	246786	38462	6300	8233	786391	1276125	39843847	448438	42407795	42654581
Unclassified	-	-	-	-	-	-	-	-	321800	127481	40240	489521	489521
By States													
Andhra Pradesh	-	-	-	-	-	-	-	-	-	2360396	-	2360396	2360396
Assam	-	-	-	-	-	-	-	-	800	583150	-	583950	583950
Bihar	-	-	-	-	-	-	-	-	179000	698612	-	877612	877612
Chhattisgarh	-	-	-	-	-	-	-	-	-	50057	-	50057	50057
Gujarat	-	-	-	-	-	-	-	-	-	8501947	-	8501947	8501947
Haryana	-	-	-	-	-	-	-	-	-	34000	-	34000	34000
Jammu & Kashmir	-	-	-	-	-	-	-	-	-	44570	40000	84570	84570
Jharkhand	-	-	-	-	-	-	-	-	651300	8197110	26930	8875340	8875340
Karnataka	26363	19389	21836	67587	-	-	-	238	1231625	8012784	25659	9270306	9337893
Kerala	140	-	-	140	-	-	-	-	99	2570	-	2669	2808
Madhya Pradesh	-	160	-	160	-	-	-	-	-	1885924	108000	1993924	1994084
Maharashtra	-	-	-	-	-	6300	-	486925	-	665622	-	1158847	1158847
Meghalaya	-	-	-	-	-	-	-	-	-	-	286467	286467	286467
Odisha	-	80000	-	80000	-	-	-	330328	-	1432492	5160	1767980	1847980
Rajasthan	5581	100380	4500	110461	38462	-	-	-	-	9021742	20000	9080204	9190665
Tamil Nadu	-	1448	238	1686	-	45690	8234	7	-	503818	-	557749	559435
Telangana	-	-	-	-	-	-	-	-	-	45494	-	45494	45494
Uttar Pradesh	-	-	-	-	-	-	-	-	-	494819	-	494819	494819
West Bengal	3658	-	-	3658	-	-	-	19827	1140	8802	-	29768	33426

Figures rounded off.

Table – 2 : Varieties of Granite in Various States

State	Variety
Andhra Pradesh	Black galaxy, Srikakulam blue, Steel grey, Paradiso, Anantapur grey, Silver galaxy, etc.
Bihar	Tiger skin, Mayurakshi blue, Sawan rose, English teak, Black-cheeta, etc.
Gujarat	Sonabadi grey, Balaram pink, Ajapur Galaxy, Godhra grey, Maharaja tiger-black, etc.
Haryana	Steel-grey porphyry, Purplish granite porphyry, Deep pink.
Karnataka	Ruby red, Fish Belly, Himalayan blue, Sira grey, Red multi, Tumkur porphyry, Hassan green, Magadi pink, Tiger black, etc.
Kerala	Tropical green, Paradiso, Kerala white, etc.
Maharashtra	Grey silk, Light pink, Jhansi red, etc.
Madhya Pradesh	Multicoloured, Black granite, etc.
Odisha	Berhampur blue, Silver grey, Seaweed green, Chilka blue, Red pearl, Jeypur and Keonjhar black, etc.
Rajasthan	Mokalsar green, Nagina green, Rosy pink, Blue Pearl, Chima pink, Bala flower, Platinum-white, etc.
Tamil Nadu	Kashmir white, Rawsilk, Paradiso, Pink multi, Colombo Juparana, Tiger skin, Kunnam black, Turaiyur blue, etc.
Uttar Pradesh	Ruby red, Jhansi red, Grey granite, Black granite, etc.
West Bengal	Bero pink porphyry, Streaky gneiss, Purulia black, Birbhum pink, Spotty black, etc.

Table – 3 : Details of Exploration for Granite during 2015-16

Agency/ State/ District	Location/ Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
GSI							
Madhya Pradesh							
Datia, Shivpuri	N/v Janakpur, Nargarh, Malkhanpur, Baroni, Sunar, etc.	-	-	-	-	-	Granite is black, grey & pink in colour. About 17 promising blocks were identified. Resources of 679175 cu.m. were established. Of these, the resources of black granite is 74,625 cu m and 6,04,50 cu m of black granite.
DMG							
Rajasthan							
Jalore	N/v Korana, Teh. Jalore	1:2000	2	-	-	6	Total 15 plots of 3 ha each were delineated. Resources were not estimated.
Sirohi	N/v Nagani, Idarla Jirawal, Amarapura, etc. Teh. Reodar	1:50000 1:10000 1:4000	100 5 1	-	-	3	Granite is greyish white in colour. 4 plots were chalked out. Resources were not estimated.
Rajsamand	N/v Chikalwas, Sayon Ka Khera, etc. Teh. Nathdwar	1:10000 1:4000	20 2	-	-	-	Granite is medium to coarse grained, porphyritic gneissic granular & grey in colour.
Barmer	N/v Nand, Shiv Ki Magri, Malba, jhari, etc. Teh. Shieo	1:50000 1:10000 1:4000	200 12 3	-	-	19	Granite is pinkish-brown to creamish in colour, medium grained and is exposed in the form of hillocks and flat outcrops. Resources were not estimated.
Chittorgarh	N/v Rajiyas, Chawandiya, Mohan Ka Khera, Teh. Gangrar	1:50000 1:10000 1:4000	300 20 2	-	-	39	Resources were not estimated. Granite is blockable.

PRODUCTION

Granite is declared as a "Minor Mineral," under the MMDR Act, 1957 and, therefore, falls under the purview of the State Governments. The data on production of granite, therefore, lacks precision as acquisition-delays makes it difficult to draw a conclusion. The production of granite compiled from the data received from various states for 2012-13 to 2014-15 is, however, detailed in Table-4.

Major production of granite in raw as well as processed form is generally from Andhra Pradesh, Rajasthan, Karnataka, Tamil Nadu and Gujarat.

The important granite producing centres in Tamil Nadu are located at Dharmapuri, Erode, Madurai, Salem, Virudhunagar and Villupuram districts.

In Rajasthan, production centres are mainly spread in the districts of Jalore, Pali, Sirohi, Barmer, Ajmer, Jaisalmer, Jhunjhunu and Jodhpur. Karnataka is another important producer of granite varieties with production centres predominantly located at the districts of Bengaluru, Mysuru, Kalaburgi, Hassan, Raichur and Kolar. The occurrences of granite have been reported from three districts of Uttar Pradesh, namely Lalitpur, Mahoba and Banda. Almost the entire production was reported from Lalitpur district. In Andhra Pradesh, important mining areas are located in the districts of Chittoor, Anantapur, Kurnool, Prakasam, Srikakulam and in Telangana,Warangal, Karimnagar and Khammam districts. Also States like Bihar, Kerala, Odisha and West Bengal produces grante.

The granite resources of Gujarat are located in the districts of Mehasana, Banaskantha, Sabarkantha, Panchmahal, Dahod, Vadodara, Amreli, Bhavnagar and Kachchh.

Details regarding production of processed granite are not available. However, it could be contrived from the data on processed material exported from which production level in the country with addition of 5 to 15% for internal use could be estimated. From all available data, it could be concluded that India is in a comfortable position to produce the required quantity of granite to meet the demand of both domestic as well as export markets.

MINING

Production of blocks of considerable size and weight is a special feature of granite mining. The process and equipment used for granite mining differ considerably from those used for mining other minerals. The mining of granite involves two important stages of operation the first actual block splitting either from sheet rock or boulder and the second operation involves many items of works, such as removal of weathered zone or overburden, opening of faces, lifting of cut blocks, transportation and many other ancillary work before and after block splitting.

Table – 4 : Production of Granite, 2012-13 to 2014-15
(By States)

(Value in ₹ '000)

State	Unit	2012-13		2012-14		2014-15 (P)	
		Quantity	Value	Quantity	Value	Quantity	Value
India			**66764237**		**82182957**		**89960399**
Andhra Pradesh	cu m	1787880	47674423	2063453	60051935	950347	32273059
Chhattisgarh	cu m	948	1896	405	810	146	321
Gujarat	m tonnes	242496	113473	212608	114300	263096	147400
Jammu & Kashmir	m tonnes	265393	17955	-	-	315732	25258
Karnataka	cu m	304015	9681453	331754	10733541	181218	5569334
Kerala	cu m	15227651	3806913	13974374	6318395	24445331	12864197
Madhya Pradesh	m tonnes	28256	34417	43267	148289	38091	132550
Rajasthan	m tonnes	2850000	4373700	3147059	3737218	2629000	4719400
Tamil Nadu	cu m	273958	748469	273958	748469	273958	748469
Telangana	cu m	-	-	-	-	1083939	33090411
Uttar Pradesh	cu m	23077	311538	24445	330000	28890	390000

S***ource:*** *State Governments.*

Mining

From manual recovery of small blocks by 'Feather & Wedge' method, quarrying technique has come a long way with the introduction of state-of-the-art equipment. There are basically two methods of quarrying techniques- the Scandinavian or the 'Drive-in' method and the Mediterranean or 'Derrick' method. Both these methods are being used by M/s.Pokarna Ltd, Tamil Nadu Minerals Ltd (TAMIN) and other prominent companies in this field by importing machines and technology from some of the finest companies in the world like Breton, Pedrini, Pellegrini etc. TAMIN received the national e-governance award for developing 'Quarry Management System' in 2015.

The Scandinavian method is highly mechanised making use of lightweight hydraulic drills capable of making drill-holes as small as 23 mm in diameter. The advantages of hydraulic drilling are- (i) less drilling time, (ii) less noise, (iii) less vibration, (iv) cleaner environment for the operator, due to dust collection and (v) the hole is free of oil and water. A primary block of roughly 4000 m^3 volume is removed with this method by drilling holes of 64 mm diameter with 114 mm spacing. Controlled blasting involves drilling of closely spaced holes and pressurising them through minimal usage of very low strength explosive to tear away of desired volume of rock from the bed rock. In order to achieve the best results through blasting, it is necessary to have a standard drilling pattern and blasting design established for each site.

'Derrick' method is named due to the use of derrick cranes. In this method, heavy-duty derrick cranes of capacity to handle 50 tonnes blocks from a depth of more than 60 m is used, which has brought revolution in granite quarrying by way of augmenting output with less cost.

'Slot Drilling & Blasting' method is used with low intensity blasting secondary cuts or splits made on primary blocks to get block sizes of 10 m^3 to 15 m^3 in volume. 'Diamond Wire Saws' is a popular technique in North America, to retrieve blocks of sizes 30 m x 10 m x 5 m is increasingly used now a days. With a wire speed of 22 to 25 m/s, it takes about 11 hours to cut a block of that size. Automatic shut down of operation in case of wire breaking/ snapping is an added feature in this technique.

Processing Industry:

There are about 2000 operating units of granite processing in the country. Processing Plants of TAMIN are located at Manali (near Chennai) and Madhepalli (near Krishnagiri), Tamil Nadu and various plants of Pokarna Ltd are located in Nalgonda, Rangareddi, Warangal districts of Telangana and Chittor, Prakasam, Srikakulam districts of Andhra Pradesh.

Large/ medium scale processing units are mostly registered under export oriented Special Economic Zones (SEZ). They possess good quality large size blocks for producing large blocks & tiles. They employ either steel-shot gang saws or multi-wire diamond saws or large format diamond circular saws. As per the 'Report of Sub-Committee under Granite Developement Council, June, 2016', the cost of processing per square feet is ₹ 50 to 60/-.There are 500 operating units in this category in the country. These units constitute bulk of the value added export of granite from India.

Small scale units cater mostly the domestic demand with exports limited to 15-20%. The products are short (height) slabs. Diamond circular saw (Multi Wheel Cutter) is the principal machine for cutting these blocks into slabs. There are 500 operating units in this category in the country. As per the 'Report of Sub-Committee under Granite Developement Council, June, 2016', the cost of processing per square feet is around ₹ 35/- for small scale units. These units normally use poor to medium quality blocks.

Micro processing units consume quarry waste namely Khandas as raw material. They use domestic equipment and their products are tiles of 60 cm x 30 cm and 30 cm x 30 cm with thickness of 1 to 2 cm. Processing cost of these units, per square feet is ₹ 20/- .There are about 1000 units operating in the country.

The block splitting from the sheet rocks or boulders is mainly done manually or in some cases by semi-mechanised methods, whereas the other operations, such as, removal of overburden, lifting & transportation of cut blocks, etc. are carried out by mechanised methods. There are a few mines which have adopted the modern method of block splitting by using 'Flame Chanelling' method. In this method, diesel fuel is mixed with compressed air to create a concentrated flame and the flame is ejected through a narrow nozzle at high pressure & temperature. The percentage recovery of granite on the whole is quite low and it varies from 5 to15% because of the prevalent unscientific mining method.

One of the modern and scientific mining methods adopted recently to enhance the recovery of dimensional blocks is that 'Water Jet Cutting' technique. In this technique, water with tremendous pressure is passed through an orifice to form a jet. This jet is used to cut into the primary blocks as well as secondary blocks. The cutting loss in this process is minimum and there is no damage to adjacent block as in case of blasting.

PROCESSING INDUSTRY

The processing of granite in India is an age-old phenomenon and started in a small way in 1930s when some trimmed blocks as kerbstones were exported to the UK. Since then, semi-hand-worked or hand-polished granite tombstones found their acceptability in the UK. Granite processing basically involves sawing or cutting of raw blocks into the tiles/slabs of required size & thickness and polishing of sawn-off surfaces. Other ancillary functions involve edge cutting, milling, boring and contouring for enhancing the quality and price of production. In India, the Processing Industry is in three sectors, namely, small-scale units, medium-scale units and 100% export-oriented units (EOU). The Processing Industry of granite in the country has developed over the years, and the share in exports of processed material has increased manifolds.

Centre for Development of Stones (CDOS), registered as a non-profit making Society, is the common facilities centre for the entire stone industry, including granite, established under the National Programme for Development of Stone Industry in India (NPDSI), which is a joint effort of Govt. of India and United Nations Industrial Development Organisation (UNIDO). CDOS was set up as an autonomous organisation by Govt. of Rajasthan and Rajasthan State Industrial Development & Investment Corpn. Ltd (RIICO) at Jaipur, with an objective to develop, promote and support the Dimensional Stone Sector and related industries in India. It also has testing centre for stones that conforms to international standards.

USES & SPECIFICATIONS

Uses

Granite is the most sought-after among all building stones. In ancient times, granite pillars and beams were preferred material to support the huge structures of temples and palaces and for making protective walls around them. With the invention of modern tools of greater hardness and polishing ability, the use of granite has rather increased on account of its aesthetic value. The modern motorised tools of tungsten carbide and brazed diamond have enabled the user to cut & polish granite as per the specifications of the Building Sector. Presently, cut and polished granite slabs of 20 mm thickness are preferred for flooring, while tiles of 10 or 12 mm thickness are used for cladding. In addition, gravestones and monuments of various shapes and sizes are also in vogue. The flexibility of the cutting tools have engendered creation of many artifacts of granite for decorative purposes.

Granite also finds its application in making garden furniture, such as, benches, fountains and many other articles which are used for landscaping and/or decorative purposes. The cut-to-size small blocks are used as cobblestone, kerbstone, road sidings and for many other innovative purposes.

Crude granites are utilised for structural purpose after little dressing & sizing, whereas processed granites are used mostly in the construction of buildings and monuments and for interiors and exterior facing. Granites, because of its superior wear resistance and non-denting quality, are used as parts in various meteorological and engineering instruments, such as, surface plates, straight edges, parallels, cubes, V' blocks and work-mounting tables of co-ordinate measuring machines.

The surface plates are used as flat datum surface whenever precise measurements of dimensions and geometrical relationships are to be carried out. For this purpose, harder variety of granite is required so that it can bear the high-degree of grinding, polishing and calibration for achieving flat surface. For its use as surface plates, granites should have properties such as, close grain size, homogeneity, high density and hardness, uniform colour, low moisture absorption and should be free from flaws.

Specifications

The properties of granite which are normally valued for exploitation are compressive strength, tensile strength, density, p-wave velocity, etc. For marketability, other requirements like colour, texture, granularity, size, water absorption, porosity, hardness, moisture content, etc. are also essential. Raw blocks should be free from normal defects like fractures, joints, shears, hairline cracks, segregation, veins, etc. (Table-5)

A snippet of BIS specifications for granite are highlighted below:

IS: 3316 - 1974 (First Revision; Reaffirmed 2008) Specifications for Structural Granite

This Standard covers section, grading and strength requirements of structural granite for various constructional uses. The general requirements as per the specifications are that granite shall be free from flaws, injurious veins, cavities and similar imperfections that would impair its structural integrity and would affect adversely its strength and appearance. The strength requirements as per IS: 3316-1974 are as follows:

i) The compressive strength when tested according to IS: 1121 (Part 1) - 1974 (Reaffirmed 2008) shall not be less than 1,000 kg/cm^2.

ii) The true specific gravity when tested according to IS:1122-1974 (Reaffirmed 2008) shall not be less than 2.6.

iii) The water absorption when tested according to IS: 1124-1974 (Reaffirmed 2008) shall not be more than 0.50%.

The shape of slabs shall be rectangular or square and of specified dimensions with tolerance in length and breadth as 12 mm and thickness 1 mm. The dimensions of blocks for masonry shall be as specified. The tolerance allowed for facing blocks is 15 mm.

IS:14223 (Part 1) - 1995; (Reaffirmed 2012) Specifications for Polished Building Stones: Part I Granite

This Standard covers physical properties and finish requirements of polished granites used for various purposes. The general requirements as per the specifications are that the granite should be free from all imperfections and deleterious minerals that may interfere with the appearance, strength, structural integrity and its amenability to take good polish. Imperfections are mostly imparted by the textural variations which is a function of degree of uniformity and the distribution of the constituent minerals. Hairline cracks/joints, flower, moles, knots, white and dark lines due to segregation of light-coloured minerals in multicoloured granite and ferro-magnesium minerals in light-coloured granites are considered to be imperfections. Granite should be free from deleterious minerals, such as, pyrite, marcasite, biotite, chlorite and ilmenite which interfere with the colour and appearance on weathering and also affect polishing characteristics.

The shapes of the slabs shall be rectangular or square and of specified dimensions with a tolerance in length and breadth as +2 mm and thickness +1 mm. The bottom face may be rough but the top surface shall be fine-polished and joint faces shall be dressed with the top surface without hollowness and spalling off.

The physical properties of granite shall conform to the requirements given in Table-5. Surface of the polished granite shall be mirror-finish without any hairline crack. The polish on the surface shall be checked with glassometer and shall not be less than 95 per cent.

On the international scene, with the formulation of European Economy, the CEN Norm has come into force. As per CEN TC 246, various standards of stones have been formulated. The objectives of these standards are to necessitate the companies to have the tests conducted for the different stones that are commercialised so as to profit the users the choice of the stone with desired physical characteristics according to the purpose intended. It has become mandatory for every company doing business with European Union to mark their products with 'CE' marking from March 2004 onwards.

POLICY

Granite is a 'Minor Mineral' under the MMDR Act, 1957. The grant of various mineral concessions for granite is, therefore, administered under the Minor Mineral Concession Rules of the respective State Governments. However, the Granite Conservation and Development Rules, 1999 aims at uniform rules for conservation, systematic development and scientific exploitation of granite resources.

The mining leases for granite are generally granted over very small area, leading to haphazardly distribution of waste dumps in the lease area, therby creating environmental concerns. Now, all the granite leases are required to obtain environment clearance for mining operations.

Table – 5 : Physical Properties of Granite as per IS : 14223 (Part 1) -1995 (Reaffirmed 2012)

Sl. No.	Characteristic	Requirements	
		Pink granite	Multicoloured & grey granites
1	Moisture content (%) (max)	0.15	0.15
2	Dry density (m/v)	2.58 to 2.63	2.60 to 2.68
3	Apparent specific gravity (min)	2.75	2.75
4	Water absorption (%) (max)	0.50	0.50
5	Porosity (%)	1.02 to 2.50	1 to 2
6	Compressive strength (kg/cm^2)	1000-1500	1300-2200
7	Tensile strength (kg/cm^2) (min)	90	90
8	Shear strength (kg/cm^2)	280-425	300-540
9	Hardness (Mohs' scale)	6 to 7	6 to 7
10	Hardness (Schmidt No.)	80-100	85-110
11	Hardness (Shore No.)	50-60	46 to 61
12	Ultrasonic pulse velocity	5000	5000
13	Resistance to wear	Not greater than 2 mm on an average and 2.5 mm for any individual specimen	Not greater than 2 mm on an average and 2.5 mm for any individual specimen

As per the Export-Import policy for 2015-20 and the Foreign Trade Policy thereunder, the imports of granite, crude or roughly trimmed and merely cut granite, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape under Exim Code 2516 are restricted. On the otherhand, worked granite blocks/tiles under Exim Code 6802 23 can be imported freely. There are no restrictions on exports of granite and items under Chapter 25.

ENVIRONMENT

The mining of granite, started initially in the bouldery zone, had little damage to the environment. As more and more blocks in huge sizes were required to meet the demand, the sheet rock was approached by making cut in the ground and by removing top soil or overburden, which resulted in general degradation of environment.

Environmental problems are similar to any opencast mining operations. The blasting and movement of heavy vehicles generate dust and aggravate air pollution in addition to noise pollution.

The processing of granite requires huge quantities of water for cutting and polishing. In some cases, kerosene and lime water are used as coolants for cutting purpose. Although most of the kerosene and lime is recycled yet there are always chances that these coolants get mixed with natural water courses.

Sludge generated during cutting needs proper disposal to avoid increased silting and pollution of the natural waterways.

For abating environmental pollution, guidelines have been spelt out in GCDR,1999. The technology for making artificial stone called Terrazzo will prove to be a boon for the utilisation of waste generated during mining and processing.

The dumping of mineral waste is a serious issue. A huge quantity of waste is generated due to granite mining and its disposal is of great concern for the mine owners. Most of granite quarries are less than 5 hectares in area; hence, it is very difficult to dump the waste within lease area.

The Hon'ble Supreme Court has in various cases pertaining to major minerals, has directed that dumping of waste outside the lease area is illegal. Therefore, it is suggested that there should be earmarked area for waste disposal and it should constitute a part of the lease area. The earmarked area may also be formed on a cluster or on individual basis, which may not be contiguous. In case of Rajasthan, the state government has taken the initiative for identification of cluster waste disposal yards. Specific land for dumping of overburden and waste of all the minerals including granite has been alotted in seven disricts of Rajasthan. This is a welcome step, but at the same time the reclamation of such waste yards should also be ascertained. This should be part of the responsibility of the mine owners using these dump yards.

The optimum utilisation of waste is very essential for the betterment of the environment. The Government of Karnataka is encouraging production of M-sand by using waste generated from the granite quarries. M/s.Robo Silicon Pvt Ltd, a M-sand manufaturing unit is utilising weathered granite rocks by crushing & grinding using 'Vertical Impact Shaft' technology for manufacturing sand of different sizes to meet the requirements of construction industry. In Karnataka, there are more than 80 M-sand plants manufacturing nearly 10 milliion tonnes sand per annum. The production of M-sand is effective substitute of river sand, which is becoming a scarce commodity.

In the direction of waste management, Government of Rajasthan has also taken initiative to encourage waste utilisation by charging nominal royalty @ ₹ 23/- per tonne for granite boulders used for building purposes. M/s.Fateh Granites in Jalore district, Rajasthan is making cobbles out of granite waste, which are widely used for construction of roads. The company has also installed a unit for artifact tiles.

Small scale units in India mostly use single blade circular saws. However, China has converted the entire capacity to multi wire saws which enhances the productivity, mineral conservation, recovery & power saving , thus, resulting in lower cost of production. Indian industry is yet to use new surface finishing techniques such as nano-titanium coating for clean environment.

WORLD REVIEW

As per the 'Report of Sub-Committee under Granite Developement Council, June, 2016', world production of granite is estimated to be around 329 million sq.m in 2014. The top five principal producing countries in descending order were China, Brazil, India, Saudi Arabia and Italy and these countries accounted for more than 93% of the global production. The key centres of Chinese stone processing have been created mainly in Shandong, Fujian and Guangdong. Their chief function is to process local and imported materials into products for decorative interior finishing. Brazil is the largest producer of natural stone in the world and well-known for producing prime varieties like Juparna, Classico and Black Tijuca from quarries located at the outskirts of Rio. Italy has a broad, in-depth know-how of stone quarrying and processing based on centuries of experience, but in the mass production segment, it has been overtaken by China, Brazil and Saudi Arabia.

Currently, the USA is the world's biggest consumer of granite and its demand is largely fulfilled by imports from Brazil, China & India. Total imports of granite by the USA amounting to 1,793,007 metric tonnes in 2015, the trio accounted for almost 85% of the total imports.

As per Internazionale Marmi E Machine Research, 2015 remained a strong year for international trade of natural stone, with trade flow of 25.7 billion euro; higher by 12.4% over the previous year. This increase was largely value driven with higher average unit value of products on the international market by the prominent players in the sector. China continued to maintain its leadership position in the global exports market with 42% share in the total natural stone exports. Italy was the second largest exporter with a share of 12.4%.

The USA, a major importer of finished natural stone, imported stone materials, primarily finished products worth 2.4 billion euro in 2015. China, Brazil & India remained the top three trading partners for USA.

The European Union (EU), one of the biggest markets for the worldwide natural stone industry with imports of 2.4 billion euro, registered a growth of 5.1% during 2015. India has also been one of the key players in the global export of natural stone, with close to 10% share of global exports.

FOREIGN TRADE

Exports

Granite is an important commodity amongst ores and minerals that have tremendous export potential. It is mainly traded in the form of crude or roughly trimmed blocks, as cut blocks & slabs; and as polished blocks & tiles. The export value of granite (total) decreased to ₹9,272 crore in 2015-16 from ₹9,832 crore in 2014-15. The share of granite (others) was 60% at ₹5,540 crore while that of crude or roughly trimmed blocks was about 29% at ₹2,700 crores. Similarly, the share of granite (polished blocks/tiles) was 5% at ₹436 crore while granite (cut blocks/slabs) was 6% at ₹597crore. China was the most important buyer for granite and its share in the total value of exports of granite was 28%, followed by USA (18%), Turkey and Germany (4% each) (Tables- 6 to 10).

Imports

In 2015-16, imports of granite (total) increased marginally to 70,288 tonnes from 65,595 tonnes in the previous year. Out of the total imports, 42,677 tonnes were of crude or roughly trimmed granite, 14,746 tonnes of cut blocks/slabs, 2,663 tonnes of polished blocks/tiles and 10,202 tonnes of other granite. Granite was mostly imported from Norway (44%), Brazil (16%) and Sri Lanka(8%) (Tables- 11 to 15).

Table – 6 : Exports of Granite :Total (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**6563271**	**98322398**	**5674568**	**92720985**
China	4195377	30221046	3336714	25904790
USA	408444	16004512	487727	16409497
Germany	83251	4051034	75112	3570038
Turkey	154471	4309348	125934	3434673
Vietnam	91248	1617379	114969	3158759
UK	57471	2951368	53596	2804487
UAE	130321	3153750	109145	2622291
Italy	172934	3116492	119342	2547349
Poland	88789	2611222	71437	2068843
Chinese Taipei/ Taiwan	163692	1894617	171641	2034626
Other countries	1017273	28391630	1008951	28165632

Table – 7: Exports of Granite (Crude or Roughly Trimmed) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**4508446**	**33917164**	**3398523**	**26999331**
China	3863841	26833711	2863781	21194164
Chinese Taipei/ Taiwan	154274	1668959	145231	1675323
Hong Kong	110670	982779	119308	908667
Italy	132261	1567565	76318	866978
Vietnam	49832	588916	37066	539323
Belgium	43424	522086	20191	387877
Poland	31736	384707	28417	347783
Thailand	15160	218207	10386	159839
USA	11273	129218	24183	148364
Norway	21260	142036	19723	139101
Other countries	74715	878980	53919	631912

Table – 8 : Exports of Granite (Cut Blocks/Slabs) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**407990**	**3659898**	**659991**	**5966548**
China	253721	2280578	435899	4088549
Hong Kong	47678	541650	53948	622706
USA	76351	300550	120450	500876
Chinese Taipei/ Taiwan	7255	186754	25143	330481
Thailand	7222	96463	7831	106741
Sri Lanka	1950	42304	3718	88220
Vietnam	3021	50318	3960	80738
Nigeria	369	8531	1091	28724
Belgium	103	1137	1149	13767
UAE	942	13273	601	10696
Other countries	9378	138340	6201	95050

Table – 9 : Exports of Granite (Others) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**1450179**	**55519131**	**1462140**	**55396946**
USA	307808	14914400	332396	15252401
Turkey	153137	4273185	124395	3395711
Germany	67948	3475778	63705	3215137
UK	49781	2745151	45354	2597397
Vietnam	36621	947035	71980	2488011
UAE	116761	2834810	97571	2336047
Egypt	44661	1345902	68443	1716073
Poland	54401	2116774	40832	1636729
Italy	36522	1423793	39108	1533101
Canada	31097	1642565	26327	1440120
Other countries	551442	19799738	552029	19786219

Table – 10 : Exports of Granite (Polished Blocks/Tiles) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**196656**	**5226205**	**153914**	**4358160**
USA	13012	660344	10698	507856
China	73182	1006883	27591	449558
Saudi Arabia	14596	294152	25169	414060
Germany	11930	543052	8543	330190
UAE	9895	266784	9500	255086
Nigeria	8221	263950	8771	239468
Belgium	5922	263175	4442	218902
UK	4093	163433	4496	163710
France	1960	131735	2675	152576
Italy	3508	116259	3785	145753
Other countries	50337	1516438	48244	1481001

Table – 11: Imports of Granite: Total (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**65595**	**2269307**	**70288**	**2484283**
Norway	25339	785112	30874	883695
Brazil	11078	384537	11022	385024
Sri Lanka	3771	271720	5674	326380
China	4997	256487	2896	206465
Italy	1991	106520	2455	192619
Ukraine	3802	129622	4746	135643
Angola	2750	81925	4721	127226
South Africa	3195	80346	4067	99669
Spain	738	23808	1012	30896
Finland	6264	90134	1223	33453
Other countries	1670	59096	1598	63213

Table – 12 : Imports of Granite (Crude or Roughly Trimmed) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**44564**	**1299709**	**42677**	**1252862**
Norway	20681	628922	20717	622070
Brazil	8948	281073	7630	234872
Ukraine	3041	111704	4196	118713
Angola	2099	63061	3705	102653
South Africa	2088	58965	2549	64641
Italy	961	36657	656	29022
Finland	5393	77257	1152	21610
Spain	584	15124	609	18497
Madagascar	493	17137	623	16280
Sri Lanka	-	-	321	7359
Other countries	276	9809	519	17145

Table – 13 : Imports of Granite (Cut Blocks/Slabs) (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**6290**	**210530**	**14746**	**371882**
Norway	3279	115511	8877	226275
Brazil	593	34351	2116	62451
South Africa	65	1950	1230	28618
Angola	451	14427	820	18641
Italy	312	7748	348	10341
Ukraine	399	8428	412	7795
Spain	107	6639	343	7630
Sri Lanka	-	-	385	4449
China	427	11912	125	3537
Germany	-	-	15	1087
Other countries	657	9564	75	1058

Table – 14 : Imports of Granite
(Polished Blocks/Tiles)
(By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**5017**	**130523**	**2663**	**76454**
Norway	1072	34228	711	21103
Brazil	564	23147	481	14859
China	902	24818	397	12780
Italy	99	5148	176	5994
Sri Lanka	471	5243	422	4854
Angola	200	4437	155	4744
Ukraine	292	7404	73	3334
South Africa	803	13642	144	3311
Baharain	-	-	30	2761
Finland	284	4965	71	1843
Other countries	330	7491	3	871

Table – 15 : Imports of Granite (Others)
(By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**9724**	**630545**	**10202**	**773085**
Sri Lanka	3300	266477	4546	309718
China	3668	219757	2374	190148
Italy	619	56967	1275	147262
Brazil	973	45966	795	72842
Norway	307	6451	569	14247
USA	26	2585	156	8566
UAE	3	133	65	6160
Ukraine	70	2086	65	5801
Spain	47	2045	60	4769
South Africa	239	5789	144	3099
Other countries	472	22289	153	10473

FUTURE OUTLOOK

India possesses one of the best granite deposits in the world having excellent varieties comprising over 200 shades. India accounts for over 20% of the world resources in granite. The total granite resources in India as on 1.4.2015 are 46,320 million cu m.

As per the Report for 12th Plan, the Dimension stone market is said to grow at a fervent pace as the demand for granite, marble, sandstone and other dimension stones and stone products is on the rise and are anticipated to grow at around 15% CAGR. A similar rate of growth in exports can also be achieved with the help of suitable policy framework, infrastructure and other facilities which the Industry expects to consolidate for augmentation of prospects. The Working Group for 12th Plan has recommended that well-planned, concerted and dedicated efforts are essentially needed for promotion of Indian stones to galvanise their export prospects. The emphasis needs to be on popularisation of Indian stones in both the traditional markets as well as other niche markets and exploration of new avenues by strengthening the activities of the Centre for Development of Stones (C-DOS) in Rajasthan by upgrading it into a national centre of excellence could render the much-needed fillip to the industry as a whole. Alternatively, other options for exporting granite and marble in processed form to maximise export earnings are to develop and promote artifacts, special decorative and ornamental items of high value addition. There is tremendous skill in the country, which can be explored and supported with special incentives. This can certainly bring about substantial foreign exchange addition, as well as significant employment generation.

There is a wide variation in the rates of royalty in different states. Royalty assessed/ calculated either on the basis of measurement of blocks or on tonnage basis. Many states have the system of royalty calculation based on block size, therefore, each block is required to be measured on site for determination of royalty and issue of transit permit. It was found that miners have to wait for weeks for site visit by the authorised person to obtain transit permit. This process seems to be highly cumbersome. In Rajasthan, the royalty is assessed on tonnage basis which is fair and easy to administer. The categorisation of blocks may be on the basis of size and grade, but the royalty calculation should be on tonnage basis category-wise.

The collection of royalty in Rajasthan has been outsourced through open auction valid for 2 years at a time. In this way evasion in royalty payments has been considerably reduced. Rajasthan model of royalty collection seems to be very practicable and other state governments may adopt this model with requisite modifications suitable to them.

There is a need to integrate environmental concern and social & economic developement of region into mineral developement programmes for a sustainable developement. The granite mining adversely impacts the environment due to removal of top soil and overburden, which results in degradation of land. The recovery of saleable granite blocks is very low and the waste is mostly in the form of granite rocks having defects of colour, cracks, grain size etc. and these wastes could be used in manufacturing M-sands. The basic objective of sustainable developement in mining is to meet the needs of the present without compromising the ability of future generations to meet their own needs.

The import of natural stone in Japan decreased in 2015, though the trend is expected to reverse owing to investments in residential buildings, commercial facilities and various other projects associated with the upcoming Olympic Games of Tokyo, 2020.